US 31 HAMILTON COUNTY MAJOR INVESTMENT STUDY

Summary Report

prepared for the

INDIANA DEPARTMENT OF TRANSPORTATION
Transportation Planning Division

March 1997

BERNARDIN, LOCHMUELLER & ASSOCIATES, INC.
6200 Vogel Road
Evansville IN 47715-4006
(812) 479-6200 (812) 479-6262 FAX

TABLE OF CONTENTS

Once downloaded, these page numbers may not correspond due to differences in software

LIST OF TABLES

LIST OF FIGURES

EXECUTIVE SUMMARY

This report provides a summary of the work activities and conclusions related to the *US 31 Hamilton County Major Investment Study*. The focus of the study is on that segment of the US 31 corridor between Interstate 465 on the south and 196th Street on the north, a segment of about 11 miles. Subjects covered include...

an analysis of existing and year 2020 forecasted traffic conditions in the US 31 corridor as well as the projected demographic and employment growth underlying the future travel conditions;

a detailed analysis of alternative "build" and "non-build" actions that might be taken to ameliorate forecasted traffic congestion in the corridor, and;

a description of the recommended alternative and a proposed phasing program for its construction.

TRAFFIC CONDITIONS

At least five out of the 23 intersections along the US 31 corridor are currently operating at level of service (LOS) "E" or "F". At the present time, about 10% of the mileage operates at LOS "E" and 36% at "F". Population in Hamilton County is expected to grow at least 58% in the three decades between 1990 and 2020. The number of households will grow approximately 88% and employment will increase 132%. Existing growth makes Hamilton County not only the fastest-growing county in the State, but in the entire Midwestern part of the country. This explosive growth translates into serious problems in the future. Vehicle-miles of travel are expected to grow 118% between 1993 and 2020. Due to increasing congestion, this growth in vehicular travel suggests a 319% growth in vehicle-hours of travel. Average daily traffic on US 31 can be expected to grow 40% to 100% depending on the location and the level of service will deteriorate to "F" throughout the entire length of the corridor.

ALTERNATIVES ANALYSIS

A total of seven alternatives that would be either partially or completely on new alignments were evaluated. In addition to these, two alternative were considered that would upgrade the existing facility to urban freeway standards. "Upgrade 1" focused exclusively on the existing highway. "Upgrade 2" was the same as Upgrade 1 with the addition of new travel lanes on SR 431. Finally, a combination of transportation system management (TSM) improvements and upgrading was evaluated. The "TSM / Upgrade" focused on upgrading US 31 from near 136th Street north and widening existing parallel facilities from 136th Street south.

Computer modeling of all the alternatives was undertaken. Completely new alignments were tested with a 6-lane cross section. The upgrade alternatives were tested with 8 lanes between 103rd and 161st Street and 6 lanes north of 161st Street. Urban single-point interchanges were used as the predominant type of interchange configuration at all access points along US 31.

Benefit-cost analysis, various system performance measures, and human / environmental considerations were used in evaluating the alternatives. *All of the benefit-cost and system performance measures point to upgrading US 31 to a freeway.* Moreover, Upgrade 2 provides significant net benefits beyond Upgrade 1. By the Year 2020, Upgrade 2 would eliminate about 1,250 accidents per year and would deliver over $429 million in time saving benefits. Depending on the final design at the southern end of the corridor, the freeway upgrade would reduce the number of capacity-deficient intersections along US 31 to 2 or less.

A determined effort to listen to the concerned public was made throughout the course of the study. This was accomplished through several public information meetings, presentations before various agency boards, and a formal survey of business managers and employees located along the corridor. The open nature of the study generated over 200 pieces of correspondence, virtually all of which expressed the hope that INDOT would solve the problem *on the existing alignment*.

The primary purpose of the survey was to assess the viability of transit and "travel demand management" (TDM) strategies within the corridor. Modes of public transit did not find wide acceptance among the respondents. However, two TDM strategies did garner significant support from both management and employees. These are telecommuting and flexible work hours. *A recommendation of this study is that the State consider pursuing policies that would encourage greater private sector implementation of telecommuting and flex time wherever appropriate.*

An environmental overview of the alternatives was conducted as a part of this study and has been compiled as a separate volume. The overview did not greatly favor one alternative over another. On the basis of published data and inter-agency coordination, no environmental constraints were identified that would preempt the construction of any of the alternatives, provided ordinary mitigation measures associated with a project of this size were undertaken.

RECOMMENDED IMPROVEMENT & PHASING PLAN

The conclusion of the alternatives analysis was that US 31 should be upgraded to urban freeway standards from 103rd Street north to 196th Street. Optionally, the project could be extended farther south to include a freeway-to-freeway interchange between US 31 and Interstate 465. It was, also, concluded that SR 431 should be improved at least to the extent of adding an additional travel lane in each direction.

The conceptual design of the highway suggested some modifications to the existing laneage. Specifically, it is recommended that the highway be constructed with 8 travel lanes beginning at 103rd Street (4 in each direction) and continuing north up to the northbound 146th Street interchange. For a short distance between exit and entrance ramps, the facility would narrow to 6 lanes (3 in each direction). Passing under 146th Street just north of the merge/diverge point with SR 431, the highway would widen out to either 11 or 12 lanes (including 1 or 2 entrance/exit lanes depending on the exact interchange option that is chosen). Continuing north, at 151st Street the highway would narrow down to 10 lanes (5 in each direction). The fifth north- and southbound lanes would be dropped at the 161st Street interchange as they become off- and on-ramps at 161st Street. Accordingly, at 161st Street the highway would be back down to the 8-lane cross section typical of the segment between 103rd and 146th streets. Continuing north, the highway would narrow to 6 travel lanes (3 in each direction) at the off- and on-ramps to SR 32. Between SR 32 and the project's northern terminus at 196th Street, this 6-lane cross section would be used.

The construction program divides the corridor improvement into 8 parts. It is recommended that construction begin with the segment between 136th and 161st streets. Construction would then systematically move south in stages without any leapfrogging down to 116th Street. Concentrating early efforts between 116th and 161st streets makes sense from the standpoint that these are the fastest growing segments of the corridor. After completion of the 116th Street area, the decision as to whether or not to build the freeway-to-freeway interchange could be made on the basis of available funding and competing needs. Delaying construction on this southern segment is also justified in that the area south of 106th Street already has more capacity than segments farther north. It also mitigates the chances that further improvements to this section would ever need to be ripped out and reconstructed with more capacity. The final two phases would then move to the north end of the corridor where traffic volumes are comparatively low and anticipated growth is farthest in the future.

Inflation estimates are based on an assumed inflation rate of 3% with construction on the first phase beginning around 2001. Given these assumptions, the 1996 price tag of $383 million cost for all of the corridor improvements would inflate to about $475 million assuming the freeway-to-freeway interchange in *not* built. If it *is* built, the $483 million cost would escalate to approximately $616 million.

More detailed information on the individual construction segments can be found in the project engineering reports associated with this study and published in separate volumes.

Chapter 1
INTRODUCTION

During the 107th Session of the Indiana General Assembly (1991), legislation was passed that directed the Indiana Department of Transportation (INDOT) to establish "commerce corridors". These corridors were defined as ...

> "that part of a recognized system of highways that: (1) directly facilitates intrastate, interstate, or international commerce and travel; (2) enhances economic vitality and international competitiveness; or (3) provides service to all parts of Indiana and the United States."[1]

The statute further directed INDOT to ...

> "undertake, as soon as possible, studies that will be required to improve the transportation corridor between St. Joseph County and Marion County. The department shall conduct an origin-destination study and may study the following:
>
> (1) Any changes needed in the location of transportation facilities to improve the corridor.
>
> (2) The environmental impact of changes in the corridor..."[2]

In response to this legislative mandate, INDOT commissioned three studies of the US 31 corridor between St. Joseph and Marion counties. The first of these studies, initiated in 1992, was to examine that segment of US 31 that traverses Howard County (i.e., the Kokomo area). In 1993, the remaining two

[1] IC 8-23-1-14.5

[2] IC 8-23-8-1.3 Section 5 (a)

studies were begun. These two studies focus on: US 31 as it passes through the urbanized portion of Hamilton County (i.e., Carmel and Westfield), and; US 31 between US 30 in Marshall County (i.e., Plymouth) and US 20 in St. Joseph County (i.e., South Bend). Collectively, these three segments were singled out because they represent the most challenging obstacles to a major improvement of US 31 throughout the length of the 122 mile corridor between I-465 at Indianapolis and US 20 at South Bend. Figure 1 shows the locations of these three study segments.

In addition to these three focused studies, a fourth study is also underway that will attempt to quantify the economic impacts to the state of Indiana of improving the full length of the corridor.

The focus of this particular report is on the Hamilton County segment of the US 31 corridor. References will be made throughout the document to the Hamilton County "study area". This study area is that portion of Hamilton County that is likely to experience some degree of urban development between now and the study's forecast year of 2020. A computer model of traffic in this area has been developed both for this study as well as its "sister study" of the I-69 / SR 37 corridor. The study area is shown in Figure 2.

MAJOR INVESTMENT STUDY

In addition to state legislation, federal transportation regulations also have a bearing on the US 31 studies. Specifically, guidelines promulgated pursuant to the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) have established a particular kind of investigation referred to as "major investment studies" (or MIS).[3] Essentially, these guidelines require that any federally-aided transportation agency that is considering a major transportation investment must provide within the study process opportunities for serious public involvement, early inter-agency coordination, and the evaluation of all reasonable alternatives, including alternative modes. The MIS must also investigate environmental considerations, whether or not this is done in the context of a formal environmental impact statement prepared pursuant to the National Environmental Protection Act (NEPA).

Accordingly, the three US 31 corridor studies (introduced above) have all been structured as MISs. This chapter will document the public involvement and inter-agency coordination that has occurred throughout the study. The heart of the entire study is the "alternatives analysis". Chapter 3 will address this subject in detail. Also included in Chapter 3 is a discussion of a special aspect of the public involvement process: a survey of workers and management located along the US 31 corridor in Hamilton County. The purpose of this survey was to aid in the evaluation of alternative modes and

[3] 23 CFR 450.318

FIGURE 1:

REGIONAL U.S. 31 CORRIDOR STUDY SEGMENTS

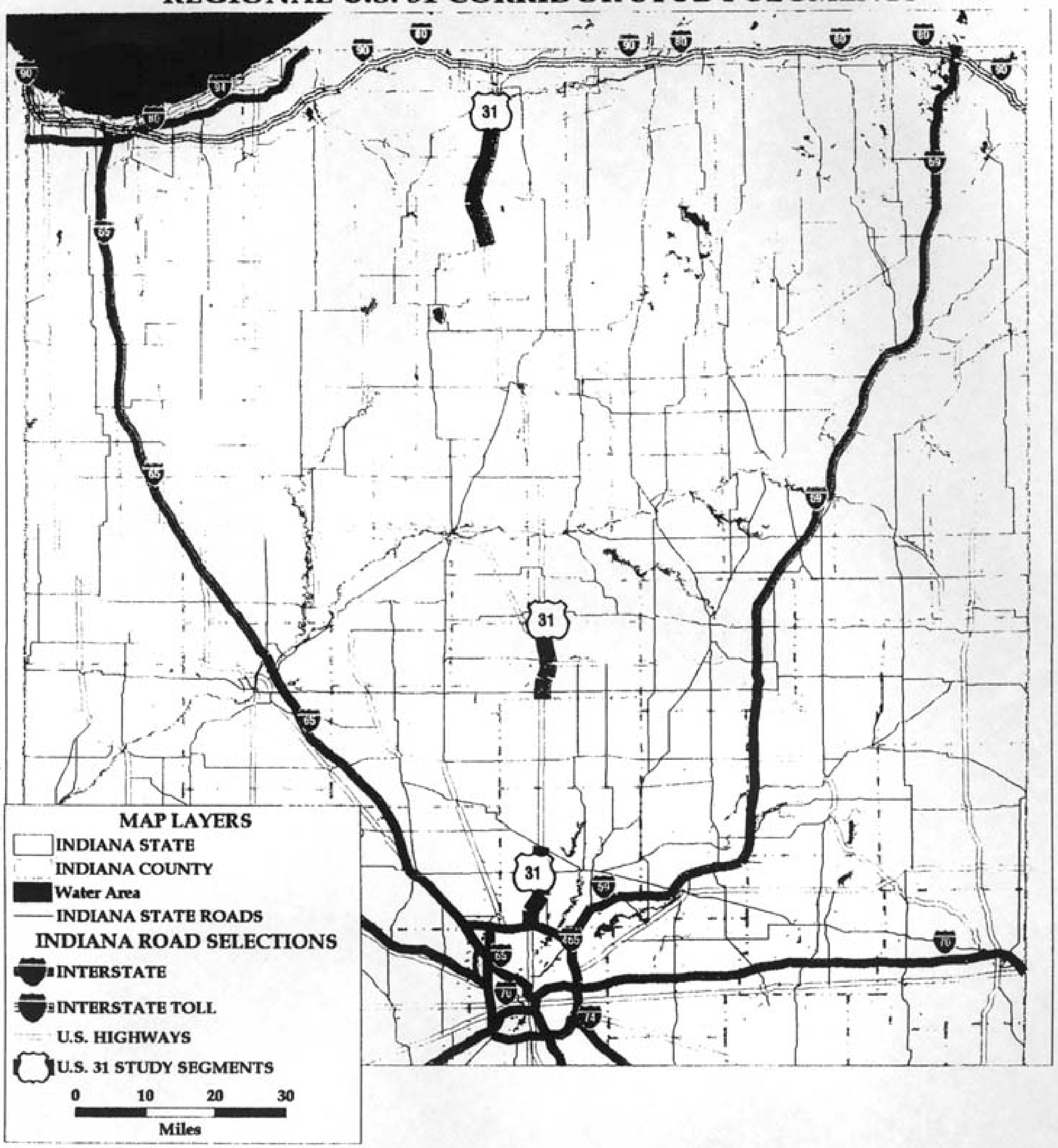
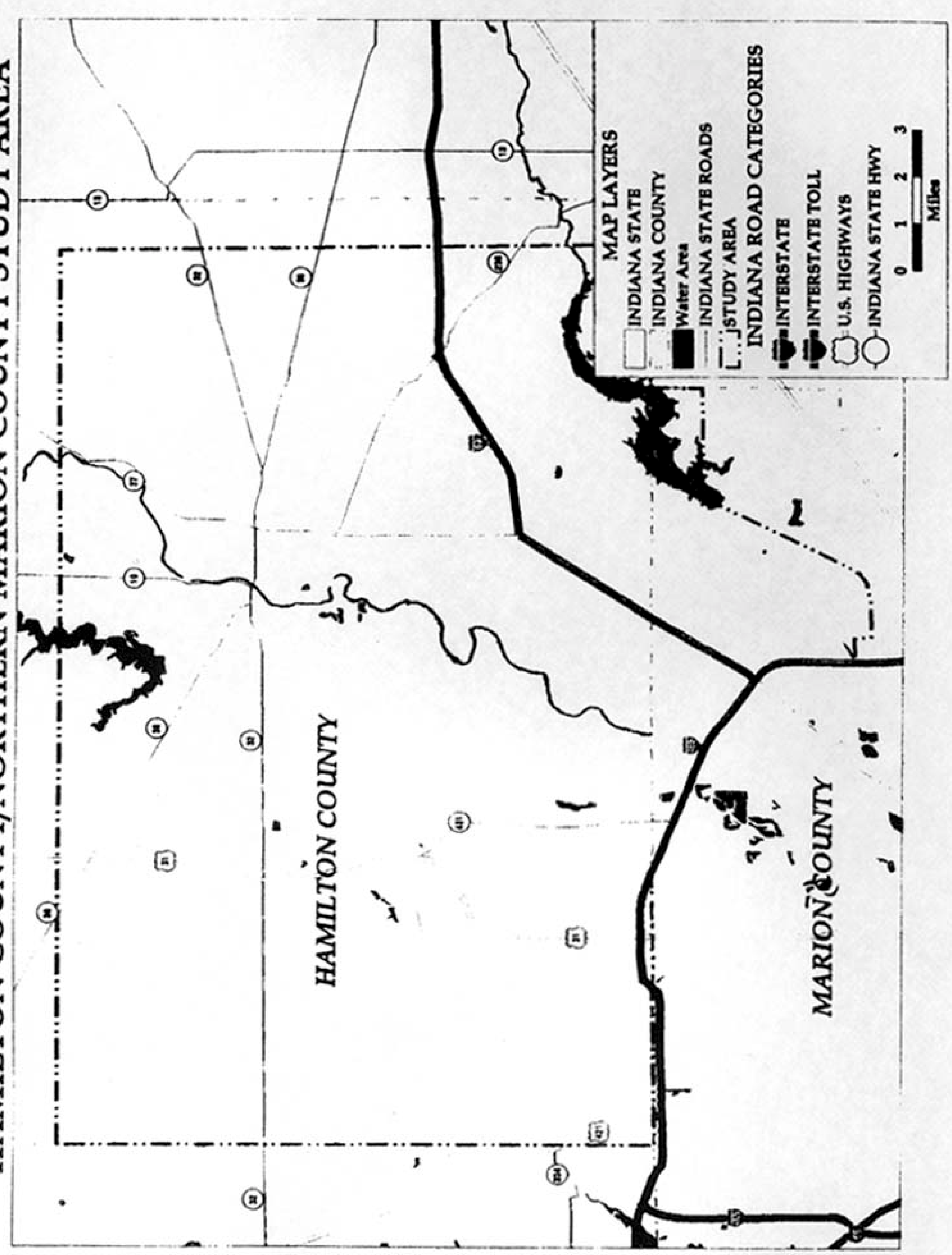


FIGURE 2:
HAMILTON COUNTY/NORTHERN MARION COUNTY STUDY AREA



travel demand management strategies (TDMs). Although it is an integral part of this MIS, the "environmental overview" is of such magnitude that it has been bound in a separate report. Aspects of the environmental overview, however, are also discussed in Chapter 3 in the context of the alternatives analysis.

PUBLIC INVOLVEMENT OPPORTUNITIES

The study was kicked off in August 1993. The first public information meeting was held on the evening of December 9, 1993 at Carmel Junior High School. The meeting was well publicized and moderately attended by Carmel and Hamilton County residents as well as members of the media. The primary purpose of this first meeting was to introduce the study and describe the scope of work. Questions were also answered and attendees were given the opportunity to "sign up" either as a member of the Study Task Force or simply to be put on a mailing list alerting them to future public meetings. Study Task Force members were subsequently invited to participate in "shirt sleeve" working sessions to advise the consultant staff on the locations of future land development.

On July 13, 1995 a second public information meeting was held at Carmel Junior High School. The purpose of this meeting was to present the alternatives under study and to solicit input from the public regarding these and other alternatives. The meeting was attended by approximately 150 people and generated a significant amount of feedback.

The final public information meetings were conducted at Washington Elementary School in Westfield. Presentations were made and public statements received at both an afternoon and evening session on July 9, 1996. Personal invitations were sent to approximately 500 people on the project mailing list and the meeting was well publicized in the local press. About 175 people participated in this round of meetings at which overwhelming support was voiced for the recommended alternative (to be discussed in Chapters 3 and 4).

EARLY INTER-AGENCY COORDINATION

In partial fulfillment of the requirements of a MIS, three separate efforts were undertaken to provide the opportunity for early inter-agency coordination. One such effort was an "issues meeting" conducted on May 9, 1995 involving the participation of several agencies. In attendance were representatives of the Indiana Department of Transportation, the Federal Highway Administration (FHWA), the Indianapolis Department of Metropolitan Development (i.e., the designated metropolitan planning organization), the Indiana Department of Environmental Management, and the Indianapolis Public Transportation Corporation/Metro. During this meeting, scope of the study was described in detail and the conclusion was reached that the requirements of a MIS were met by the scope. A copy of the meeting's agenda and minutes can be found in Appendix 1.

The second early coordination effort relates to the study's "environmental overview". While this environmental overview does not meet the formal requirements of NEPA for an environmental impact statement (EIS), it is designed so that most of the data needed to complete an EIS would already be collected if INDOT subsequently decides to pursue construction of the US 31 improvement. As a part of this data collection process, "early coordination correspondence" was sent out to all of the local, state, and federal agencies typically contacted in NEPA studies. The correspondence package included 50 pages of detailed information regarding Hamilton County, in general, as well as data relevant to the alternative alignments (at that time under consideration). Six tables, eighteen figures, and nine appendices were also included as a part of the early coordination package. A complete listing of the agencies that were contacted is included in Appendix 2. The agency responses generally did not identify additional information beyond that which had already been provided in the mailing.

In addition to these efforts, several formal presentations were given throughout the course the study to the Policy and Technical committees of the Indianapolis Department of Metropolitan Development. A presentation was also given to the Carmel/Clay Planning Commission and numerous consultative meetings were held with officials of Hamilton County, the City of Carmel and the Town of Westfield.

THE MIS SUMMARY REPORT

The balance of this report documents in summary form the results of this major investment study. Chapter 2 focuses on both existing and future conditions within the study corridor. Particular attention is given to describing levels of service on US 31 under present conditions and the degree to which these levels of service will deteriorate by 2020 based on the study's forecasts of population and employment.

In Chapter 3 alternative solutions designed to alleviate congestion on US 31 are introduced and evaluated. The prospective solutions run the gamut from low-cost travel demand management (TDM) strategies to relocation of the highway on entirely new alignments. The alternatives are analyzed using several different evaluation criteria. Finally, a recommendation is made on the basis of this comparative analysis.

In the final chapter, the component parts of the proposed improvement are analyzed and recommendations are made with respect to the phasing of construction.

Chapter 2
EXISTING & FUTURE CONDITIONS

INTRODUCTION

In order to lay the groundwork for a discussion of the alternative strategies and improvements that might "work" in the US 31 corridor, existing traffic conditions need to be understood. Moreover, in a high growth corridor such as US 31, reasonable long-range forecasts of traffic conditions *assuming no improvements are made* must also be established. This chapter will address these subjects.

Specifically, existing traffic conditions will be discussed in terms of average annual daily traffic volumes (AADT) and levels-of-service (LOS). Both "segment" and" intersection" levels-of-service will be presented. Following this discussion, the major findings of the origin-destination study that was undertaken as a part of this project will be presented and their implications discussed.

Having established the existing conditions, underlying demographic and economic projections of Hamilton County for the year 2020 will be discussed. The implications of this growth will then be addressed in terms of traffic growth. Finally, the future "do nothing" levels-of-service will be presented and compared with existing conditions.

"EXISTING-PLUS-COMMITTED" TRAFFIC CONDITIONS

Before discussing traffic conditions, some technical definitions need to be provided. There is a technical distinction between "existing" and "existing-plus-committed" traffic. Strictly speaking, the traffic volumes reported in the balance of this chapter are "existing-plus-committed" traffic as opposed to precise existing conditions as they are found on the streets today. Existing-plus-committed traffic volumes are the approximate traffic counts that *would* exist if certain "committed" projects were on the ground today. The existing-plus-committed traffic numbers come from a computer traffic model that is capable of simulating complex "what-if" scenarios. The reason for discussing traffic flow in terms of the "existing-plus-committed" condition is that it allows for an "apples-to-apples" comparison with forecast year 2020 conditions; by that time the committed projects will, in fact, be built. For the purposes of this study, the committed projects include: the 96th Street Bridge, the widening of 116th Street and the 116th Street Bridge and the bridging of 146th street across US 31.

Figure 3 depicts *existing-plus-committed (EPC)* traffic conditions along US 31, SR 431 and on I-465 between the Michigan Road and Allisonville Road interchanges. The figures represent 24-hour average daily traffic (ADT) volumes.

(A comparison of these EPC data with existing traffic shows almost identical conditions except in a few places. This is the case on I-465 between US 31 and Allisonville Road. Between US 31 and SR 431 on I-465, existing conditions are about 4,000 ADT higher. Going over the White River, existing traffic is approximately 13,000 ADT higher. In both cases, the difference is due to the expected effect of the 96th Street Bridge.)

Traversing US 31 from I-465 to the north, traffic volumes exceed 60,000 ADT south of 103rd Street. Volumes quickly drop to the 50,000 ADT range between 106th and 111th streets and continue to decline to the 30,000 ADT range until US 31 merges with SR 431 (Keystone Avenue) traffic. At this juncture, volumes currently jump to over 50,000 ADT. This is another unusual location where EPC volumes will fall to around 43,000 ADT once the 146th Street bridge and associated improvements are constructed. North of this point, volumes will then begin to diminish slowly. Volumes are still in the range of 30,000 ADT in the vicinity of SR 32 and do not drop appreciably until somewhere north of the study area boundary.

LEVEL-OF-SERVICE

In order to makes sense out of traffic data, transportation engineers have devised a concept called "level-of-service" (LOS). This concept makes use of a qualitative scale or "grading" system ranging from "A" to "F", whereby "A" indicates completely unencumbered, free-flow driving conditions and "F" represents forced or "breakdown" flow with delays. These thresholds between levels-of-service are based on established "maximum service flow rates". These service flow rates represent vehicular "capacities" defined in terms of "passenger car equivalents-per-hour-per-lane". In order to have a convenient tool for estimating *daily* LOS, generalized 24-hour capacity criteria have been developed for the US 31 corridor projects and may be found in Table 1.[4] For purposes of the US 31 Hamilton County MIS, a LOS of "D" has been

[4] Generalized 24-hour capacity criteria have been based on hourly service flow rates borrowed from the *1994 Highway Capacity Manual* (Special Report 209, Transportation Research Board, Washington, D.C.)

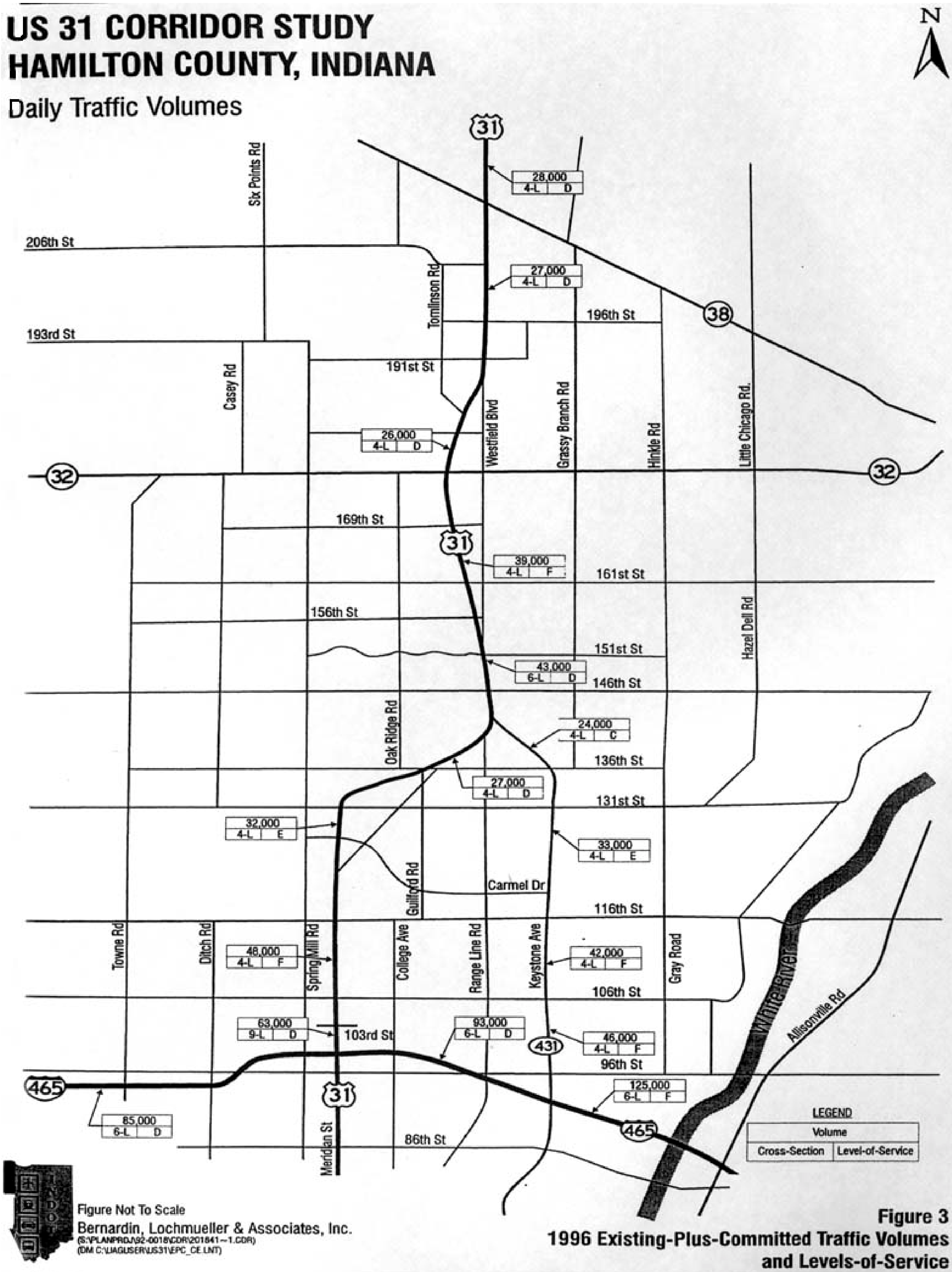


Figure 3
1996 Existing-Plus-Committed Traffic Volumes and Levels-of-Service

Table 1
GENERALIZED CAPACITY CRITERIA - MAXIMUM DAILY TRAFFIC VOLUMES
U.S. 31 Hamilton County Major Investment Study

Level of Service	Multi-Lane Highways (Non-Freeways)			Rural State Highways		Urban Arterials (including Urban State Highways)				Rural Arterials	
	4-lanes	4-lanes divided	6-lanes divided	2-lanes	3-lanes	2-lanes	3-lanes	4-lanes	5-lanes	2-lanes	3-lanes
A	9,600	10,800	16,200	3,600	4,400	3,700	4,500	7,400	9,000	2,600	3,200
B	16,000	18,000	27,000	6,000	7,300	6,200	7,500	12,300	15,000	4,300	5,300
C	22,100	24,800	37,100	8,300	10,100	8,600	10,500	17,200	21,000	6,100	7,400
D	25,900	29,100	43,700	9,800	12,000	10,300	12,600	20,600	25,100	7,200	8,800
E	29,400	33,000	49,500	11,500	14,000	12,300	15,000	24,600	30,000	9,100	11,100
F	--	--	--	--	--	--	--	--	--	--	--

Level of Service Criteria developed from the current edition of the *Highway Capacity Manual*, Special Report 209, Transportation Research Board, Washington DC, 1994. The basis for the criteria is Table 8-10 on page 8-14 for two-lane highways and Table 7-11 on page 7-20 for multi-lane highways. The criteria has been generalized and assumes a peak hour percentage (K) of 10%, directional factor (D) of 0.6, 15% commercial vehicle percentage, and level terrain conditions.

GENERALIZED CAPACITY CRITERIA - MAXIMUM DAILY TRAFFIC VOLUMES
U.S. 31 Hamilton County Major Investment Study

Level of Service	Freeway (Interstate 465) (55%/45% Directional Split)				Freeway (Interstate 69 and U.S. 31) (60%/40% Directional Split)			
	4-lanes	6-lanes	8-lanes	10-lanes	4-lanes	6-lanes	8-lanes	10-lanes
A	22,000	33,000	44,000	55,000	20,000	30,000	40,000	50,000
B	35,000	53,000	70,000	88,000	32,000	48,000	64,000	80,000
C	52,000	79,000	105,000	131,000	47,000	71,000	94,000	118,000
D	66,000	99,000	132,000	165,000	60,000	90,000	120,000	150,000
E	74,000	117,000	156,000	194,000	68,000	101,500	136,000	170,000
F	--	--	--	--	--	--	--	--

Level of Service Criteria developed from the current edition of the *Highway Capacity Manual*, Special Report 209, Transportation Research Board, Washington DC, 1994. The basis for the criteria is Table 3-1 on page 3-9. The criteria has been generalized and assumes a peak hour percentage (K) of 10%, 15% commercial vehicle percentage, and level terrain conditions.

established as the planning goal for the forecast year of 2020. Using these criteria, Figure 3 depicts existing-plus-committed level-of-service ratings along US 31, SR 431 and I-465. Scanning US 31 from south-to-north, a slightly different picture takes shape as compared to the traffic volumes. Because of the wide, 9-lane highway between I-465 and 103rd Street and the main entrance to Thomson Electronics, the LOS is presently an acceptable "D", despite having the highest traffic volume in the entire corridor. However, as the wide cross-section narrows from 6- to 4-lanes north of 106th Street, the existing LOS drops to "F". Since the highway generally remains a 4-lane facility from this point north, levels of service are correlated closely with traffic volumes. LOS conditions improve to "E" from 116th Street to 131st and improve further to "D" between 131st and Rangeline Road. Between the merge with Keystone Avenue and 151st Street, the highway once again widens out to 6 lanes providing a continuation of LOS D . North of 151st Street to SR 32, heavy congestion once again occurs with an associated LOS "F". North of SR 32, conditions improve to LOS "D" throughout this 4-lane section. Along SR 431, levels-of-service are in the "E" to "F" range from I-465 to around 136th Street where they improve markedly to LOS "C". On I-465 between Michigan Road and Keystone Avenue, the level-of-service is D . Moving to the east, traffic volumes grow and levels-of-service deteriorate accordingly to F between Keystone Avenue and Allisonville Road.

Up to this point the discussion has focused on "segment" levels-of-service. Intersections are also rated according to level-of-service criteria. These criteria are listed in Table 2.

Table 2
LEVEL-OF-SERVICE CRITERIA FOR INTERSECTIONS
US 31 Hamilton County Major Investment Study

Signalized Intersections		Unsignalized Intersections	
Level-of-Service	Average Stopped Delay (seconds/veh)	Average Total Delay (seconds/veh)	Expected Delay to Minor Street Traffic
A	< 5	< 5	Little or no delay
B	5.1 - 15.0	5.1 - 10.0	Short traffic delays
C	15.1 - 25.0	10.1 - 20.0	Average traffic delays
D	25.1 - 40.0	20.1 - 30.0	Long traffic delays
E	40.1 - 60.0	30.1 - 45.0	Very long traffic delays
F	> 60	> 45	*

Table 3
RECENT LEVELS-OF-SERVICE AND DELAY AT US 31 INTERSECTIONS[5]
US 31 Hamilton County Major Investment Study

Intersection	Average Delay	Level-of-Service
96th Street	16.8	C
I-465 East-Bound	13.5	B
I-465 West-Bound	9.5	B
103rd Street	21.6	C
106th Street	21.5	C
111th Street	51.1	F
116th Street	27.7	D
Old Meridian Street	1.0	A
126th Street / Carmel Dr.	24.5	C
131st Street	3.5	A
136th / Guilford Road	35.7	D
Rangeline Road	12.9	B
Greyhound Pass	29.5	D
151st Street	33.7	D
Westfield Blvd.	93.4	E
156th Street	19.6	C
161st Street	52.3	E
169th Street	141.8	F
SR 32	54.8	E
181st Street	26.8	D
Blackburn Road	0.8	A
191st Street	4.4	A

[5] Shading indicates that the intersection is currently unsignalized. Data are based on peak-hour turning movement counts collected in 1993 if south of 146th Street. Otherwise, counts were made in 1994.

Using LOS™ software which estimates delay at intersections given input assumptions regarding peak-hour volumes, roadway geometrics, traffic signal phasing / timing, and percentage trucks, intersection levels-of-service along US 31 were computed. These LOS and delay statistics are shown in Table 3.

It should be pointed out that, as fast as development has happened within the past few years, the LOS and delay statistics shown in Table 3 are almost certainly optimistic for certain intersections at the present time. The peak-hour turning movement counts on which Table 3 are based were recorded in 1993 for intersections in Clay Township (i.e., south of 146th Street) and in 1994 for intersections farther to the north. It is likely that 103rd, 136th, Rangeline Road, and Greyhound Pass are all currently experiencing more severe congestion than is indicated in Table 3.

In summary, at least 5 out of the 23 intersections on US 31 are currently operating at level-of-service "E" or "F". However, only 1 of these is a signalized intersection (i.e., SR 32). The highway segment LOS analysis indicates that: about 54% of US 31 in the study area operates at LOS "D"; 10% operates at LOS "E", and; 36% operates at level of service "F".

ACCIDENT DATA

Accident data were collected by INDOT during a three-year period from January 1, 1990 through December 31, 1992. During these three year, there were 933 accident in the Hamilton County US 31 corridor. These accidents resulted in 505 injuries and 5 deaths. Over 40% of the accidents were rear-end collisions. The usual cause of this kind of accident is the combination of high traffic volume, high speeds, and numerous traffic signals.

ORIGIN-DESTINATION DATA

Having reviewed current conditions along the corridor in terms of traffic volumes and levels-of-service, the focus of discussion will now shift to one of the important surveys comprising the major investment study. It will be recalled from Chapter 1 that the Indiana legislature mandated INDOT to "... conduct an origin-destination study". These types of surveys are particularly valuable in the process of developing computer-based transportation models for forecasting traffic and "testing" the feasibility of alternative highway concepts. Since most of the remainder of this report will be focused on *forecasted* conditions, a discussion of the origin-destination (O-D) data and other socioeconomic factors influencing the development of the forecasting model will follow.

The specific type of O-D study that was conducted is generally referred to as a "cordon line survey", because data are collected at an imaginary linecordoning off the study area. The survey was conducted in October 1993 using videocameras to record license plates at all major roads and highways entering the study area.[6] Inbound and outbound plates were subsequently "matched" using a computer program capable of making probabilistic matches even when individual license plate characters could not be read. "Matched" license plates represent *"origin-destination pairs"* denoting comparatively long-distance traffic *moving through the study area.*

The survey results showed that out of the approximately 443,000 vehicles crossing the cordon line, about 150,000 (or 34%) have both origin and destination *outside* of the Hamilton County study area (see Figure 2 in Chapter 1). By way of comparison, only 8.5% of traffic crossing the Howard County (Kokomo) study area boundary were "through trips". It should be understood, however, that a large part of Hamilton County's relatively high percentage has to do with the fact that its study area is really a suburban outgrowth of the Indianapolis metropolitan region, and; therefore, many of the "through trips" actually represent local traffic.

At the US 31 north side survey station (near 196th Street), total inbound and outbound traffic was around 29,000 ADT. Of this total, about 14,500 (exactly 50%) were through trips. At the opposite end of the corridor (near 96th Street), there were approximately 32,000 in- and outbound trips, of which around 15,300 (or 48%) were through trips. Tables 4 and 5 provide some detail on the major origins and destinations pertaining to US 31.

Table 4
MAJOR THROUGH TRIP DESTINATIONS FROM NORTH & SOUTH US 31
US 31 Hamilton County Major Investment Study

From-->To	US 31 N	US 31 S	SR 431	I-465 W	I-465 E&S
US 31 N	0	1,279	608	3,243	909
US 31 S	1,735	0	518	2,760	369

Table 5
MAJOR THROUGH TRIP ORIGINS TO NORTH & SOUTH US 31
US 31 Hamilton County Major Investment Study

From-->To	US 31 N	US 31 S
SR 431	702	495
I-465 W	2,246	1,416
I-465 E&S	811	3,097

[6] *Hamilton County, Indiana Traffic Model: Development, Validation, Forecasts & Use*, Bernardin, Lochmueller & Associates, Inc., July 1996.

The shaded cells in Tables 4 and 5 represent origin-destination "pairs" that use the entire length of US 31 from the northern survey station to I-465. These through O-D pairs accumulate to about 8,500 trips. These trips translate to between 20% and 40% of the total 1993 traffic on US 31 *south of the SR 431* merge (depending on the exact location). (Note: These data are as of 1993 as opposed to the 1996 volumes shown in Figure 3.) This compares with 10% to 20% of the total traffic passing through the Kokomo area on US 31. North of the SR 431 merge, approximately, 11,500 through trips use US 31. The increase is attributable to traffic to and from Keystone Avenue as well as points east and south along I-465. These through trips comprise between 30% and 50% of the US 31 traffic volume north of SR 431.

These data have broad implications for the balance of the study. It is apparent that SR 431 already serves as a kind of US 31 bypass for traffic moving between US 31 N and points to the southeast. Accordingly, south of the SR 431 merge, a new bypass location to the east of US 31's current alignment would almost certainly serve very little purpose. If the forecasts (to be discussed below) suggest major growth in these O-D pairs, logic suggests that adding additional capacity to SR 431 would probably make more sense than a new eastern alignment. On the other hand, the data imply that north of the SR 431 merge, new alignments *may* make sense, since they would likely divert a significant number and percentage of US 31 travel off of the existing facility. In order for a new western alignment to be feasible south of the SR 431 merge, it would need to either tie back into SR 431 or, if it were to proceed south of the SR 431 merge, it would have to be sufficiently attractive to divert a significant amount of local traffic from US 31.

DEMOGRAPHIC & EMPLOYMENT PROJECTIONS

In addition to O-D and traffic data, socioeconomic factors such as population, households, employment and household income all serve as input variables to the computer travel demand model used throughout this study. Consequently, the year 2020 traffic forecasts derived from this model hinge to a large degree on the forecasts of these socioeconomic variables.

The forecasting process began with the development of forecast control totals for Hamilton County as a whole. These were then adjusted down to "fit" the smaller study area. The increment of forecast growth to the year 2020 was then geographically allocated among approximately 500 traffic analysis zones that comprise the study area. This allocation process involved a participatory land use planning effort which included input from many local planning and engineering professionals as well as elected officials. This section of the report will briefly describe the forecasting process and its results.

THE FORECASTING PROCESS

Control total population forecasts were developed using the "cohort survival-labor force linkage" method. Several forecasts were made based on a reasonable range of input assumptions with respect to projected labor force growth (largely a result of in-migration to Hamilton County), changes in labor force participation rates, and fertility. From the population forecasts, associated household forecasts were developed that took into account the expected continuing decline (albeit at a slower pace than in the past) in the average number of persons-per-household. At the end of this process a high and a low forecast was established. These forecasts were not intended to bracket extreme growth possibilities, but rather were based on reasonable combinations of assumptions. However, based a recent Census Bureau mid-decade estimate of population, the low forecast has been thrown out because of the extremely high level of growth experienced in Hamilton County during the first half of this decade.[7]

Since the modeled study area does not include all of Hamilton County, it is reasonable to assume that at least some portion of the forecasted population (and associated housing) growth will occur in the four relatively rural townships located outside of the study area boundaries. Based on historical patterns observed from the last two censuses and with the concurrence of the Hamilton County Planning Commission, it was assumed that 8% of the forecasted housing growth would take place in this peripheral region. Accordingly, this percent was deducted from the control total for purposes of land use allocation. On the other hand, since the modeled study area includes a part of northeast Marion County, the growth allocated to this area in the regional long-range transportation planning process was incorporated in the forecasted land use data set.

County-wide employment forecasts were developed using the "step-down econometric" method. This methodology computes local shares in employment (at the 1-digit standard industrial classification level) as a function of historical growth in national and/or statewide employment. Forecasted non-retail employment growth was reduced by 9% to allow for expected development outside of the study area boundaries. However, it was assumed that all retail growth would develop inside the study area.

[7] *Estimates of the Population of the United States by County and Township*, Current Population Report, Bureau of the Census, U.S. Department of Commerce, March 1996.

With the forecast control totals completed, a series of "delphi" or consensus-building planning sessions were held during the week of February 6, 1995 at the Indiana Government Center to allocate the expected growth to individual traffic analysis zones. All members of the technical review committee and study task force (for both this study as well as the I-69 / SR 37 corridor study) were invited to participate. Approximately 50 people participated in these sessions. Individual sessions were held for: (1) Carmel/Clay Township, (2) the Noblesville area, (3) the Fishers area, (4) the Westfield area, and (5) the northeast Marion County area.

Members of the delphi sessions made use of numerous planning tools (both graphic and tabular) to assist in the allocation/land use planning process. The members were asked to estimate both high and low growth scenarios. These values were occasionally the same for small areas with known development plans or areas expecting little growth.

The forecasted database developed in the delphi sessions was subsequently compared with the established control totals for the study area. As is commonly the case, the delphi sessions resulted in an overestimate of growth compared to the control totals. Consequently, the allocated growth was then adjusted downward to reconcile them with the control totals. This was accomplished by dividing the study area into "probable growth areas". Areas farthest away from currently developing areas were assigned a "least probable" percent growth, while areas near existing development were assigned higher percentage growth. Areas with least probable growth were adjusted downward more than areas assigned to a higher percentage growth classification.[8]

SUMMARY OF SOCIOECONOMIC FORECASTS

Projected growth statistics for select socioeconomic variables are reported in Table 6 and Figures 4 and 5. Perhaps the most notable point to make regarding these forecasts is that Hamilton County is growing at an extraordinarily fast pace relative to most of the rest of Indiana and even most of the country. A recent news article reported ...

> "Hamilton County not only is the fastest-growing county in the state, but it leads all counties in the Midwest and has been the 43rd fastest- growing county nationally since 1990."[9]

Using the study's "high growth scenario" (which in light of a recent Census Bureau estimate may prove low), Hamilton County's population can be expected to grow at an average annual compounded rate of 1.54% during the three decades between 1990 and 2020. Households will grow at an even faster rate of 2.13%-per-annum and employment at a staggering rate of 2.85%. By way of comparison, using the same forecasting methods, the US 31 / Howard County Corridor Study projected effective annual growth rates of 0.24%, 0.36%, and 1.25% for population, households, and employment, respectively.

[8] For more detail, see *2020 Trip Forecast Procedures for Hamilton County, Indiana*, Bernardin, Lochmueller & Associates, Inc., January 1996.

[9] Indianapolis News, April 11, 1996

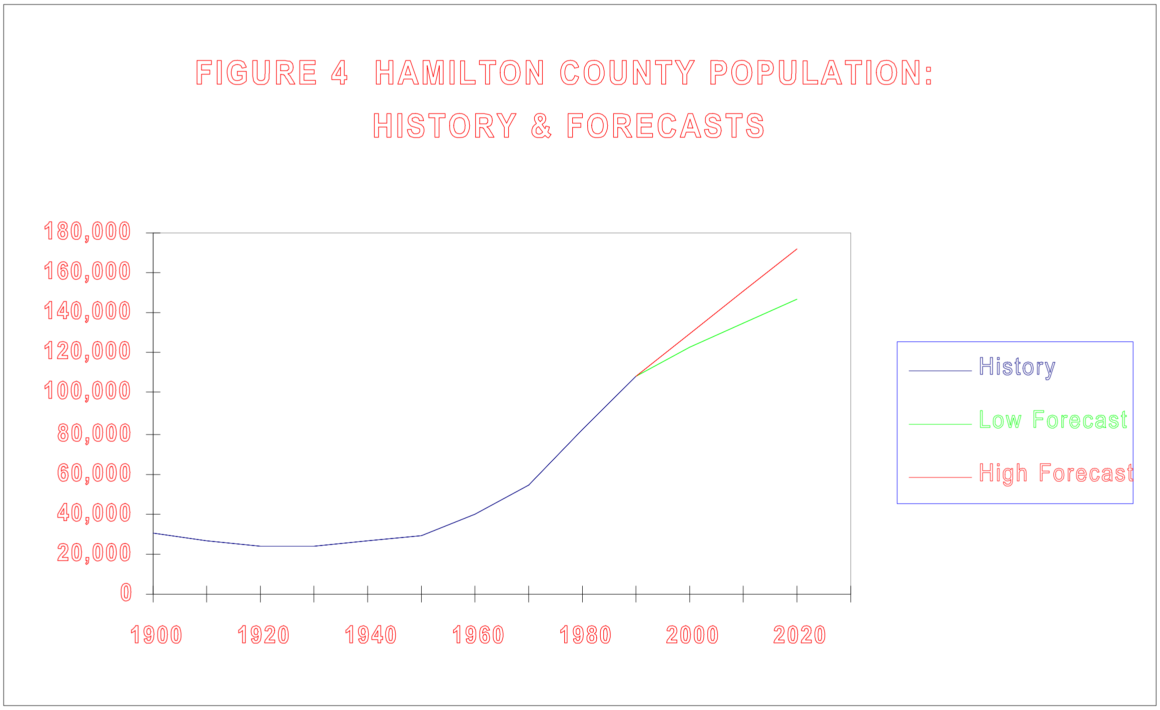


FIGURE 4 HAMILTON COUNTY POPULATION:
HISTORY & FORECASTS
180,000
160,000
140,000
120,000
100,000
80,000
60,000
40,000
20,000
0
1900
1920
1940
1960
1980
2000
2020
History
Low Forecast
High Forecast

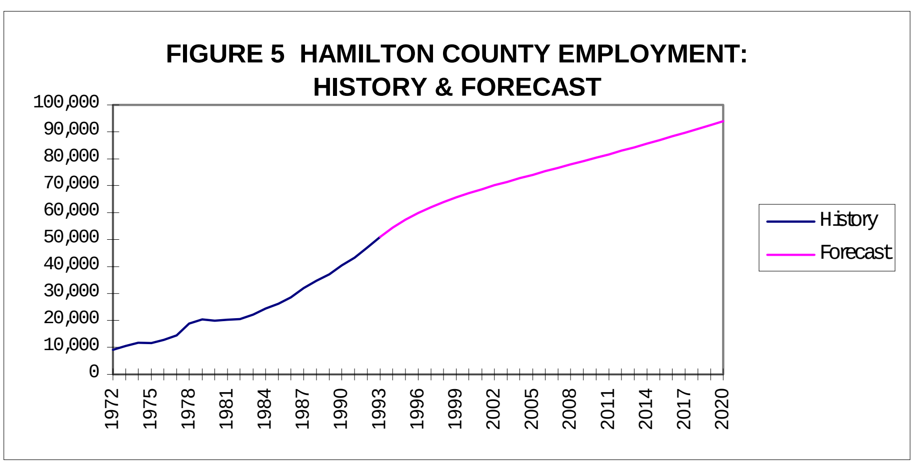


FIGURE 5 HAMILTON COUNTY EMPLOYMENT:
HISTORY & FORECAST
100,000
90,000
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
1972
1975
1978
1981
1984
1987
1990
1993
1996
1999
2002
2005
2008
2011
2014
2017
2020
History
Forecast

Table 6
HAMILTON COUNTY POPULATION, HOUSEHOLDS & EMPLOYMENT FORECASTS: 1990-2020
US 31 Hamilton County Major Investment Study

	1990	2020 "High Scenario"	Percentage Growth	Annual Compound Growth Rate
Population	108,936	172,300	58	1.54
Households	38,721	72,906	88	2.13
Employment (Place-of-Work)[1]	40,426	93,930	132	2.85

[1] Non-agricultural employment consistent with *County Employment Patterns* definition of "covered employment"

EXTERNAL TRAVEL FORECASTS

The goal of consistency with the City of Indianapolis' larger metropolitan area planning efforts has been an important consideration in the development of the Hamilton County transportation model forecasts. Since the model is meant to be a refined sub-area planning tool within the larger Indianapolis region, and; further, since it is critical that recommendations from this study be consistent with the regional MPO, the forecasts of external travel were based on the "existing plus committed" forecasts from the (recently updated) Indianapolis Long-Range Plan. Specifically, forecasted traffic on roads in the Indianapolis model that correspond to external stations in the Hamilton County model were obtained and adjusted somewhat to account for differences in the models' base years and traffic counts. Location-specific growth factors were developed using the same percentage "splits" between through traffic and traffic with either an origin or destination inside the study area as exist in the base year model.[10]

PROJECTED GROWTH IN TRAVEL DEMAND

Once all of the input variables and external travel forecasts were developed, the Hamilton County TRANPLAN transportation model was run to simulate travel demand in the year 2020. A basic assumption of this scenario was that no additional roadway improvements would be undertaken beyond the "committed projects" discussed earlier in this chapter. On the basis of this modeled scenario, several statistics describing the expected growth in travel demand are summarized in Table 7. Perhaps the most notable point to make is that vehicle-miles of travel (VMT) can be expected to grow at a faster rate than the growth in population (closer to the expected rate of employment growth). Moreover, given the "no-build" assumption underlying this model

[10] The forecasted through trip table was then computed using the standard FRATAR trip distribution method in the TRANPLAN travel demand model software.

run, congested vehicle-hours of travel (VHT) will increase at a rate disproportionately faster than forecasted VMT. The 5.45% annual growth rate in VHT reflects the serious reductions in average speeds that would be associated with added highway congestion and intersection delays. When intersection delay and congestion are incorporated in the computations, effective average speeds can be expected to drop from 24.4 to 13.1 mph.

Table 7
HAMILTON COUNTY FORECASTED VMT, VHT & THROUGH TRAFFIC GROWTH: 1993-2020
US 31 Hamilton County Major Investment Study

	1993	2020 "High Scenario"	Percentage Growth	Annual Compounded Growth Rate
Vehicle-Miles of Travel (VMT)	4,771,420	10,389,482	118	2.92
Congested Vehicle-Hours of Travel (VHT)	195,215	817,729	319	5.45
External-External Travel	149,686	245,208	64	1.84

YEAR 2020 "EXISTING-PLUS-COMMITTED" TRAFFIC CONDITIONS

Based on the above socioeconomic, land use and through travel forecasts, we are now in the position to compare current and forecasted traffic conditions. In making these comparisons, an important underlying assumption is that the major road network will remain unchanged with the exception of the "committed" projects.

Figure 6 depicts year 2020 traffic on the existing-plus-committed network and can be compared directly with Figure 3. As the figure suggests, traffic volumes can be expected to grow anywhere from about 40% to 100% on US 31 depending on the exact location; moreover, some of the highest volume locations will see some of the highest percentage growth.[11]

Even more significant than the forecasted traffic volumes are the levels-of-service (LOS) associated with those volumes. By the year 2020, the LOS on US 31 highway segments will deteriorate to "F" throughout the entire length of the corridor in the Hamilton County study area. Further, it should be noted that the traffic forecasts far exceed the minimum threshold values for LOS "F".

[11] In order to counterbalance the possibility that the demographic forecasts may be on the low side, these forecasts are based on a fairly liberal modeling assumption with respect to the trip distribution step in the modeling chain. A more conservative assumption would still see US 31 traffic growth between 33% and 88%. Even assuming the more conservative growth, there would be no difference in the forecasted LOS and minimum lane requirements.

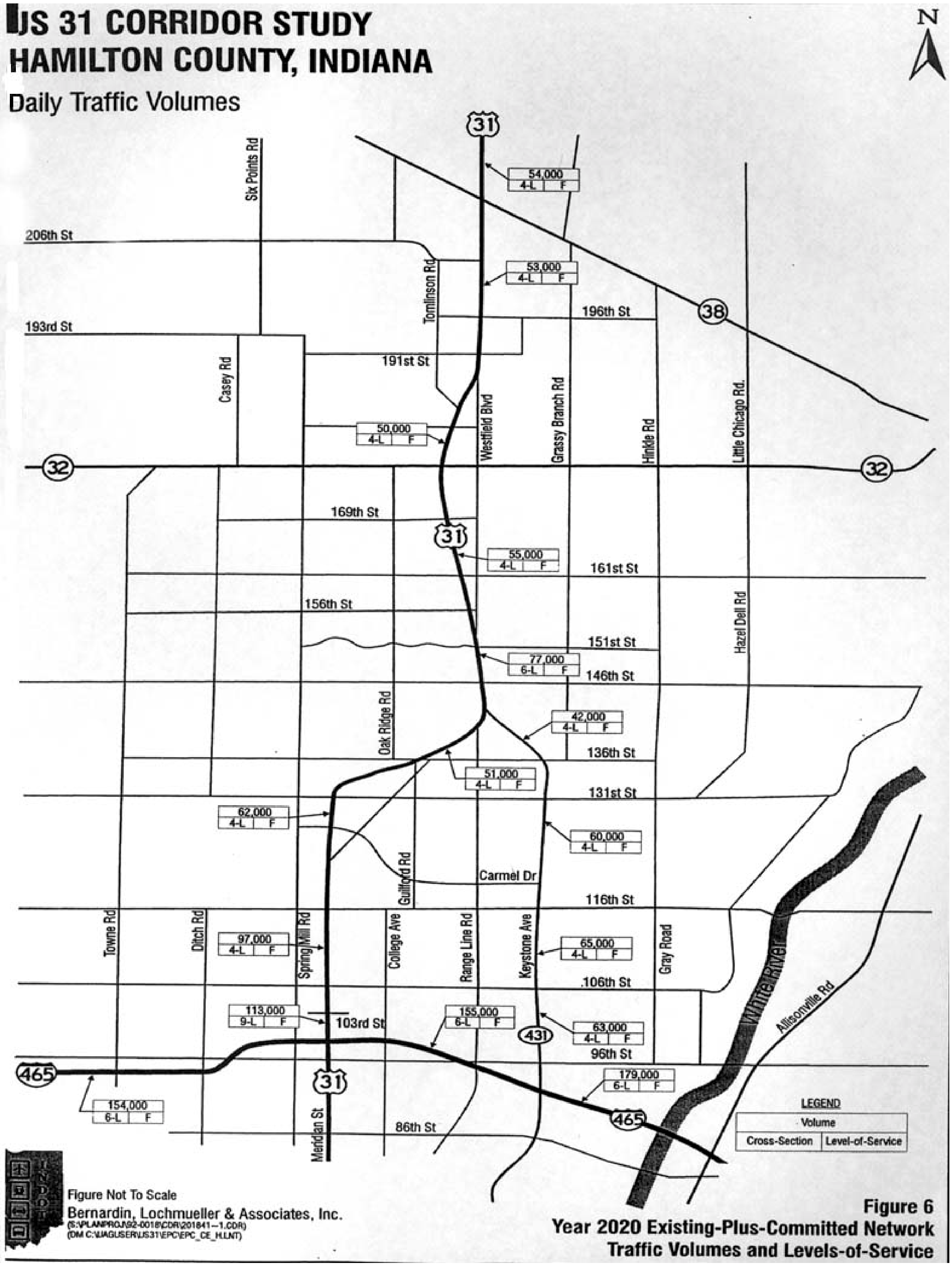


Figure 6
Year 2020 Existing-Plus-Committed Network
Traffic Volumes and Levels-of-Service

Table 8
YEAR 2020 "NO-BUILD" LEVELS-OF-SERVICE AND DELAY AT US 31 INTERSECTIONS[12]
US 31 Hamilton County Major Investment Study

Intersection	Average Delay	Level-of-Service
96th Street	67.6	F
I-465 East-Bound	27.8	D
I-465 West-Bound	>120	F
103rd Street	58.8	E
106th Street	54.6	E
111th Street	>120	F (E if signalized)
116th Street	>120	F
Old Meridian Street	>120	F
126th Street / Carmel Dr.	>120	F
131st Street	>120	F
136th / Guilford Road	>120	F
Rangeline Road	65	F
Greyhound Pass	>120	F
151st Street	>120	F
Westfield Blvd.	>120	F (B if signalized)
156th Street	>120	F (E if signalized)
161st Street	>120	F (E if signalized)
169th Street	>120	F (E if signalized)
SR 32	>120	F
181st Street	>120	F (B if signalized)
Blackburn Road	22.6	C (B if signalized)
191st Street	>120	F (B if signalized)

[12] Shading indicates that the intersection is currently unsignalized.

In similar fashion, delay will skyrocket at US 31 intersections and associated levels-of-service will almost uniformly deteriorate to "E" or "F". Table 8 reports the forecasted LOS by intersection and may be compared directly with Table 3. As Table 8 implies, the addition of new traffic signals along US 31 would probably be warranted and would improve certain "intersection levels-of-service". On the other hand, the table does not show levels-of-service by intersection "approach" or individual "movement". Accordingly, what is not shown is that the LOS on the US 31 mainline approaches to these presently unsignalized intersections would clearly deteriorate if they were signalized causing significantly more delay on US 31 itself.

In summary, over the long haul the "do-nothing" alternative (even with the addition of new signalization) would not be very attractive to the traveling public that makes use of US 31 in Hamilton County.

Chapter 3
ALTERNATIVES ANALYSIS

INTRODUCTION

In the previous chapter, the existing and forecasted traffic conditions along US 31 were described. The conclusion of that chapter was that over the long-haul, the "do nothing" alternative will result in intolerable congestion and delays. Chapter 3 will describe several possible alternatives to doing nothing. Following the description of these alternatives, the evaluations of those alternatives will be addressed. Finally, the conclusions of the alternatives analysis will be reported.

THE ALTERNATIVES

The alternative courses of action that have been considered in this study fall into five broad categories. These categories are ...

completely new alignments

new alignments combined with an upgrade of a part of the existing highway to freeway standards.

freeway upgrade of the highway on the existing alignment

transportation system management (TSM) improvements

alternative modes and travel demand management (TDM) strategies.

"BUILD" ALTERNATIVES

The first four groupings listed above might generically be referred to as "build alternatives". The last category dealing with alternate modes and TDM strategies is sufficiently different from the other groupings to warrant a separate discussion. Among the "build alternatives", the analysis included a total of 7 new alignment or combined new alignment/freeway upgrade alternatives. The analysis considered one combined TSM/upgrade alternative.

Brief descriptions of these alternatives are given below...

Alternative 1 *Partially shared alignment with existing US 31.* Beginning at the southern end, this concept involves a freeway upgrade from 103rd Street north to 131st; thence, the alignment would cut cross-country in a northwesterly direction to Spring Mill Road at about 136th Street; thence, it would proceed north along Spring Mill Road to near 169th Street; proceeding northeast, cross-country to its northern terminus at US 31 near 196th Street. The length of this alternative is 11.3 miles (or 18.2 kilometers).

Alternative 2 *Partially shared alignment with existing US 31*. This concept involves a freeway upgrade from 103rd Street north to 131st; thence, the alignment would cut cross-country in a northwesterly direction to Spring Mill Road at about 136th Street; thence, it would proceed north along Spring Mill Road to near 186th Street; proceeding northeast, cross-country to its northern terminus at US 31 near 216th Street. The length of this alternative is 13.2 miles (or 21.2 kilometers).

Alternative 3 *Partially shared alignment with existing US 31*. This concept involves a freeway upgrade from 103rd Street north to 131st; thence, the alignment would cut cross-country in a northwesterly direction to Ditch Road at about 146th Street; thence, it would proceed north along Ditch Road to near SR 32; proceeding northeast, cross-country to its northern terminus at US 31 near 216th Street. The length of this alternative is 14.1 miles (or 22.7 kilometers).

Alternative 4 *Completely new alignment*. Commencing at a new interchange with I-465 at Ditch Road, this alignment would proceed north along Ditch Road to SR 32; proceeding northeast, it would cut cross-country to its northern terminus at US 31 near 216th Street. The length of this alternative is 13.9 miles (or 22.4 kilometers).

Alternative 5 *Partially shared alignment with existing US 31*. This concept involves a freeway upgrade from 103rd Street north to 131st; thence, the alignment would cut cross-country in a northwesterly direction to Ditch Road at about 146th Street; thence, it would proceed north along Ditch Road to near SR 32; proceeding northeast, cross-country to its northern terminus at US 31 near 196th Street. The length of this alternative is 12.5 miles (or 20.1 kilometers).

Alternative 6 *Completely new alignment*. Commencing at a new interchange with I-465 at Ditch Road, this alignment would proceed north along Ditch Road to SR 32; proceeding northeast, it would cut cross-country to its northern terminus at US 31 near 196th Street. The length of this alternative is 12.3 miles (or 19.8 kilometers).

Alternative 7 *Completely new alignment*. Commencing at a new interchange with I-465 at Township Line Road, this alignment would proceed north along Towne Road to near 166th Street; proceeding northeast, it would cut cross-country to its northern terminus at US 31 near 216th Street. The length of this alternative is 15.0 miles (or 24.1 kilometers).

TSM/Upgrade *Combination freeway upgrade of existing US 31 with improvements to other local streets.* In this concept, there would be no change to US 31 south of 136th Street. US 31 would be converted to a freeway per the other "upgrade" alternatives north of 136th Street. Spring Mill Road would be upgraded to a 4-lane facility with continuous center turn lane from 96th Street north to 136th Street. From this point east to its interchange with US 31, 136th Street would be upgraded to the same capacity as Spring Mill. Similarly, 96th Street would be upgraded between Spring Mill Road and US 31. On the east side of US 31, Pennsylvania would be constructed to a similar roadway between 103rd and 131st Street. The length of this alternative is 11.0 miles (or 17.7 kilometers).

Upgrade 1 *Freeway upgrade to existing US 31.* In this concept, US 31 would be upgraded to an urban freeway from 103rd Street to the vicinity of 196th Street. The length of this alternative is 11.0 miles (or 17.7 kilometers).

Upgrade 2 *Freeway upgrade to existing US 31.* This concept is the same as Upgrade 1 with the addition of one added travel lane in each direction on Keystone Avenue (SR

431) from 96th Street north to US 31. The length of this alternative is 11.0 miles (or 17.7 kilometers).

In the alternatives analysis the upgrade alternatives would be *eight lanes, urban freeways between 103rd and 161st Streets* with the exception of a short six lane section in between exit and entrance lanes inside the 146th Street interchange. North of 161st Street the highway would narrow to six lanes. (The reader should be aware that the upgrade concept has been expanded since the alternatives analysis was conducted. This expansion will be discussed in the following chapter.)

The US 31 segments of the shared alignment alternatives (i.e., alternatives 1, 2, 3, and 5) would all have the same cross section as the upgrade. The shared alignment alternatives would then narrow down to six lanes north of their divergence from the existing US 31 alignment.

The new alignment alternatives (i.e., 4, 6, and 7) would all be constructed as six lane urban freeways.

(With the exception of the TSM / Upgrade alternative, all of the alternates were also modeled with one less lane in each direction. These "narrow" alternatives were found to have inadequate capacity and were less cost effective. They are, therefore, not discussed further in this report. Data, however, are available on these narrow alternatives.)

Figure 7 depicts the various corridor concepts. As the figure shows, Alternatives 1 and 2 are closely related. Both make use of Spring Mill Road from 136th Street to the north. The difference lies in the location of their northern termini.

Similarly, Alternatives 3 and 5 are related. They both make use of Ditch Road from around 146th Street to the north and differ only in the their northern termini.

Alternatives 4 and 6 are the same except with respect to their northern termini. Otherwise, they both run along the east side of Ditch Road and serve as a western bypass to existing US 31.

Alternative 7 is similar to Alternatives 4 and 6, insofar as it would serve as a far western bypass running along Towne Road. In one sense, Alternative 7 is unique in that it is the direct result of public input.

Alternatives 2, 3, 4, and 7 are related in that they all share the same far northern terminus near 216th Street. Similarly, Alternatives 1, 5, and 6 all share a northern terminus near 196th Street.

US 31 CORRIDOR STUDY
HAMILTON COUNTY, INDIANA

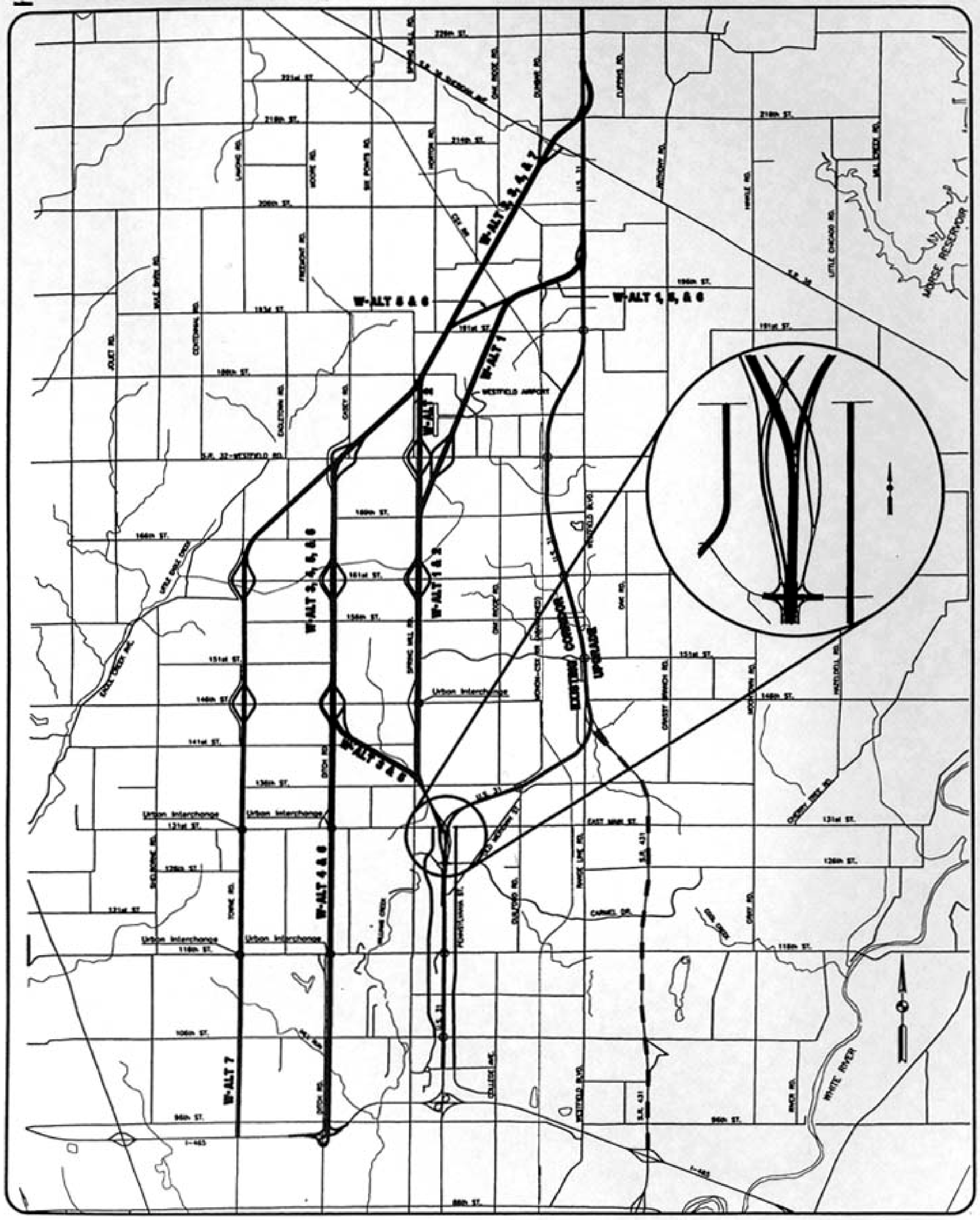


Figure Not To Scale
Bernardin, Lochmueller & Associates, Inc.
S:\PROJECTS\CARMEL\PRESENTA\EXUPWB_5 02/14/97 10:13 BITZ

FIGURE 7
ALTERNATIVE CORRIDOR CONCEPTS

ACCESS

All "shared alignment" alternatives would have fully-directional, grade-separated interchanges at 106th, 116th, 126th (i.e., Carmel Drive), 146th and 161st streets plus SR 32. These are Alternatives 1, 2, 3, and 5.

The "new alignment" alternatives (i.e., 4, 6, and 7) would have fully-directional, grade-separated interchanges at 116th, 131st, 146th and 161st streets plus SR 32. These would also have a new interchange on I-465.

"Upgrade" alternatives 1 and 2 would also be designed with fully-directional, grade-separated interchanges. These would be located at 106th, 116th, 126th (i.e., Carmel Drive), 136th / Guilford Road, 146th / SR 431, 151st, 161st, SR 32, and 191st Street. (An interchange at Union / Westfield Blvd. could substitute for the 191st Street interchange.) The upgraded US 31 mainline would bridge over 111th, 131st, Rangeline Road, 156th, 169th, and 181st streets.

In the TSM / Upgrade alternative, interchanges would be located at the same cross-streets as Upgrade Alternatives 1 and 2, except for the three southern-most locations (i.e., 106th, 116th, and 126th). These three locations would remain as at-grade intersections.

DESIGN FEATURES

The "upgrade alternatives" would be designed entirely as an "urban freeway". The typical cross section would include 3- to 4- 12' (3.66 meter) lanes in each direction separated by a concrete median barrier wall and 12' shoulders on either side of the barrier. There would also be a 12' outside shoulder. The design would include extensive use of retaining walls and urban "single-point interchanges" to conserve on the need for additional right-of-way. (See Chapter 4 for discussion of single-point interchanges.)

The "new" alignment alternatives (i.e., 4, 6, and 7) would also be designed as urban freeways in the southern, heavily developed (or developing) portions of the corridor. Single-point interchanges would be located at 116th and 131st streets. Around 146th Street, the design concept would change over to a "rural freeway". A typical cross-section would include 3- 12' (3.66 meter) lanes plus a 10' (3.05 meter) outside shoulder in each direction separated by a 52' (15.9 meter) grass median plus 4' (1.22 meter) inside paved shoulders. Rural diamond interchanges would be used from 146th Street north.

"Shared" alignment alternatives 1 and 2 would be designed as urban freeways up to the vicinity of 161st Street. This would include a single-point interchange at 146th Street. North of this point, they would shift to a rural freeway design. Shared alignments 3 and 5 would transition to a rural cross section farther south around 146th Street. In these alternatives, the 146th Street interchange would be designed as a rural diamond.

ACCESS ROADS

The upgrade alternatives (excluding the TSM / Upgrade) as well as all 4 shared alignment alternatives include an access road plan to allow for the orderly development of the US 31 corridor. On the west side of US 31, an access road would be extended north from the 106th Street entrance to Thomson Electronics. This road would terminate at 131st Street. On the east side of the highway, those segments of Pennsylvania Road that currently do not exist would be constructed (presumably by the land developers) . It would also be extended north to 131st to allow for a continuous road from 103rd to 131st .

For the upgrade alternatives, several other access roads would be constructed. These include: (1) a northerly extension of Rangeline Road under the mainline up to 146th Street on the west side of US 31; (2) development of access roads between 146th and 151st streets on both sides of the highway (see Chapter 4 for greater detail); (3) a road paralleling the mainline on its west side extending north and south from 156th Street to provide access to residential properties that currently front on US 31; (4) roads on the west side of the mainline south of 169th Street, south of SR 32, and from SR 32 to 181st Street, and; (5) of the a realignment of Union Street in Westfield under the mainline connecting with 191st Street on the west side of US 31.

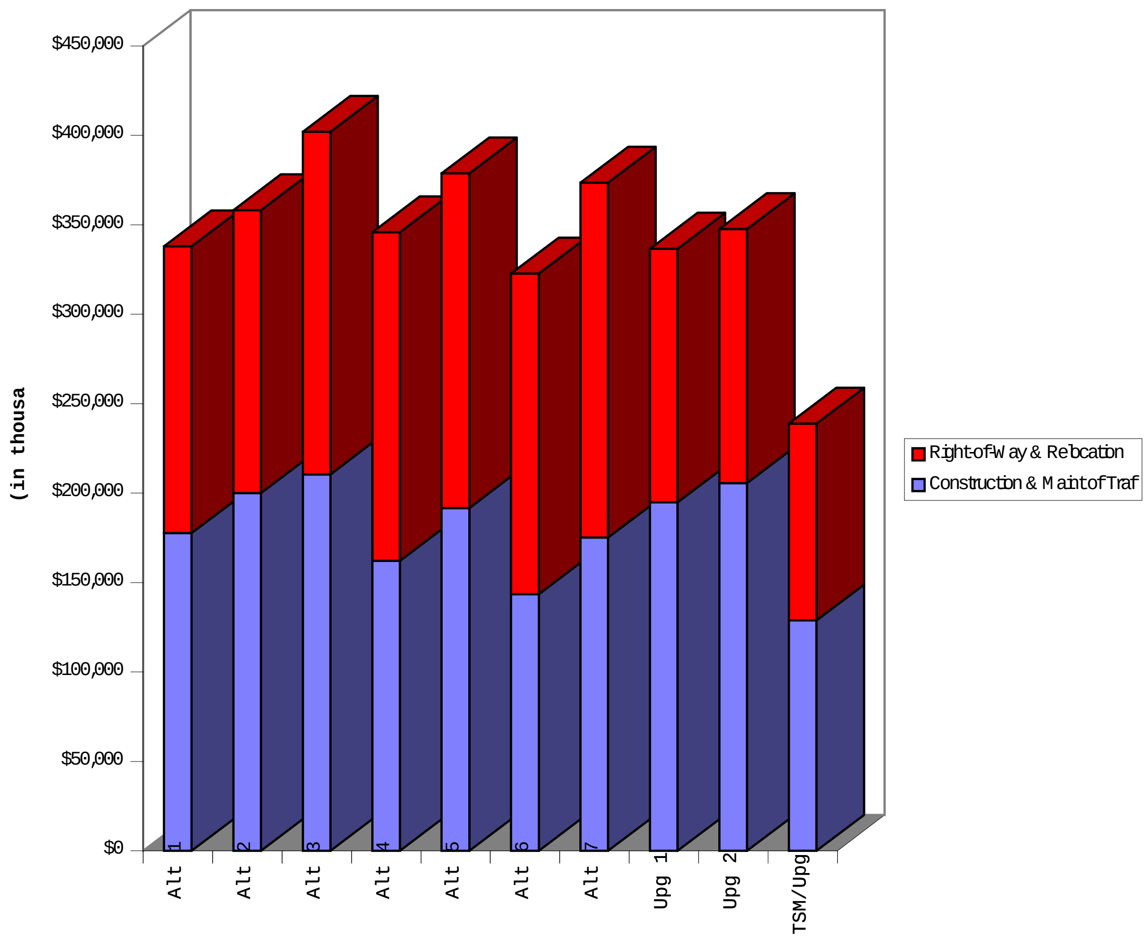
ALTERNATIVE COSTS

Costs estimates were computed for each alternative based on preliminary engineering design work including proposed profile-grades, earthwork computations, etc. Field visits by the consultant staff and the staff of INDOT's Division of Land Acquisition were conducted. All costs have been estimated in constant 1996 dollars; however, included in the costing are estimates of right-of-way, relocation and damages *based on a higher degree of real estate development* than presently exists. This was done in recognition of the fact that development is occurring at such a high rate within these corridors, that by the time land acquisition takes place, there will be many more homes and, to some extent, more businesses than exist today.

Figure 8 summarizes the cost estimates used in the alternatives analysis. (Since the completion of the alternatives analysis, additional work has been done on the recommended improvement costs to be discussed in Chapter 4.)

The costs for the 10 "build" alternatives range between a low of approximately $239 million for the TSM / Upgrade to a high of $402 million for Alternative 3. Estimated right-of-way, relocation and damages are exceptionally large cost components of these alternatives. In fact, for three of the alternatives, these right-of-way related costs are actually expected to exceed the construction costs.

FIGURE 8 COST OF ALTERNATIVES



	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	Alt 6	Alt 7	Upg 1	Upg 2	TSM/Upg
Construction & Maint of Traf	$177,650	$200,090	$210,447	$162,260	$191,706	$143,642	$175,241	$194,779	$205,679	$128,859
Right-of-Way & Relocation	$160,360	$158,124	$191,472	$183,600	$186,988	$179,117	$198,288	$141,905	$141,905	$109,944
TOTAL	$338,010	$358,214	$401,919	$345,860	$378,694	$322,759	$373,529	$336,684	$347,584	$238,803

Note: In Chapter 4, a more refined cost estimate for the recommended improvement is presented.

EVALUATION CRITERIA

Three broad criteria were used in the alternatives evaluation process ...

- a specific type of economic analysis commonly referred to as "user benefit-cost analysis";
- transportation performance measures, and;
- human / environmental concerns.

More discussion of each evaluation criteria is provided in the following pages.

USER BENEFIT-COST ANALYSIS

The type of analysis described in this report is limited to economic benefits that would accrue to prospective "users" of the highway improvements. These benefits have traditionally been defined as *reductions in user costs associated with...*

- fewer accidents
- time savings, and
- improved vehicle operating conditions.

In the presentation of findings, the discussion is organized along these lines. Other legitimate economic benefits that might be associated with additional highway investment in the corridor -- business expansion, new business attraction to the region, increased disposable income, etc. -- are not considered in this report. A separate study of the US 31 corridor from Indianapolis to South Bend is currently underway to address these macroeconomic issues.

It should be pointed out that the data reported on the following pages pertain to the entire study area covered by the TRANPLAN travel demand model developed jointly for this project and the *I-69 / SR 37 Corridor Study*. This is an area encompassing approximately 258 square miles of southern Hamilton and northeast Marion counties. In other words, *all* travel time savings, accident reductions, etc. that might be expected to occur throughout the street and highway system as a direct or indirect result of the prospective highway investment are counted; not just those accruing to traffic on US 31 (or the alternative in question).

No distinction has been made in this analysis between Indiana highway users and traffic with one or both trip end outside of the state. Accordingly, the analysis does not isolate the benefits and costs associated with citizens of the state of Indiana exclusively.

A wide array of assumptions and cost factors operate in the background of any economic analysis. These factors all have at least some influence on the results. The following discussion will document the assumptions and other input variables employed in the analysis.

CONSTRUCTION SCHEDULE AND ANALYSIS PERIOD

The assumed opening year of the highway is 2005 with construction beginning in the year 2000. This opening year and construction period has been chosen not so much out of a conviction that the roadway investment will actually take place so soon. Given the current shortage of highway capital development funds, it is likely that it will take considerably longer. Rather, it was chosen in order to allow for a direct comparison between the benefit-cost results of this project and those being performed for other large corridor projects in Indiana, all of which have an hypothetical build-out period and opening date of five years and 2005, respectively.

In the case of the US 31 corridor, because of the high degree of long-range growth forecast for the area, the assumption of 2005 is a conservative one. A later opening date would result in "better" benefit-cost computations.

The analysis has been computed for a 30-year period. In other words, using the 30-year analysis period, user benefits have been computed for each year from 2005 through 2029 (inclusive) and discounted back to 2000. For the years between 2005 and 2020, user benefits were based on traffic data linearly interpolated between the base year (1993) travel demand model and the forecasted 2020 travel demand model. Between 2020 and 2029, user benefits were extrapolated using the same rate of growth.

The capital costs of the project were assumed to be spent over the 5-year period from 2000 through 2004 in equal annual increments. These costs were also discounted back to 2000, i.e., the beginning of the project. All financial data - costs and benefits - are expressed in uninflated, constant 1996 dollars.

Any user benefits derived from segments of the alternative plan opened prior to its final completion in 2005 were not included in the analysis. Conversely, any temporary increase in user costs resulting from motorist inconvenience or traffic detours during construction were excluded from the analysis.

OPERATION AND MAINTENANCE COSTS

In addition to the capital costs of the project, projected operation and maintenance costs (O&M) were added to the discounted cost stream between 2005 and 2029. INDOT's Operations Support Division was consulted for an estimate of annual maintenance costs on a per-lane-mile basis for both the Interstate system and for the balance of the state highway system. INDOT's average lane-mile maintenance costs for Interstates and non-Interstates were reported at $1,900 per year and $3,670, respectively. Non-Interstate maintenance costs per-lane mile tend to be more expensive due to the additional costs associated with maintenance of traffic, detours, etc. Estimates of total annual maintenance costs were computed for each alternative network and then compared with the maintenance costs for the "No-Build" network (i.e., existing-plus-committed). The difference between the alternative and the "No Build" represents the estimate of maintenance costs associated with the alternative. The conservative assumption was made that "average" annual maintenance costs would begin in the first year of highway operation and continue at the same amount throughout the life of the analysis period.

In order to complete the O&M estimates, additional costs related to increased police patrol and communications were added.[13] No increases in general highway administrative costs were included in this analysis, since this cost category is fixed overhead and not directly correlated with roadway mileage.

Total annual operation and maintenance costs associated with each of the alternatives can be found in Table 9.

Table 9
ANNUAL OPERATION & MAINTENANCE COSTS BY ALTERNATIVE
(in thousands)
US 31 Hamilton County Major Investment Study

Alternative Plan	O & M Costs
Alternative 1	$227
Alternative 2	$272
Alternative 3	$295
Alternative 4	$339
Alternative 5	$256
Alternative 6	$300
Alternative 7	$407
TSM / Upgrade	$45
Upgrade 1	$64
Upgrade 2	$86

[13] The per-mile estimates for police patrol and communications were obtained from the *Corridor 18 Feasibility Study* (Wilbur Smith, 1995).

Clearly, the Upgrade alternatives provide a significant advantage over all others, since they directly affect US 31 (as it is currently defined). Insofar as the highway already exists, normal maintenance cost are already being incurred. Accordingly, the increment of new costs associated with the upgrade improvement are substantially lower than the alternatives that introduce entirely new (center line) mileage to the Indiana state highway system.

RESIDUAL VALUE

At the end of the economic analysis period, the improvements will clearly have some remaining useful life. This "residual value" was estimated and its discounted value was netted out of the cumulative discounted cost stream. Estimation of the project's residual value was based on typical highway life cycle costs for five major capital cost components. The five components and their associated useful lives are listed below ...

Right-of-way	Infinite life
Earthwork	100 years
Structural Costs	70 years
Road Base	50 years
Other	30 years

With this life cycle information, the residual value for each alternative was computed based on the length of the economic analysis period. For example, using a 30-year analysis period, the residual value of the project's earthwork was computed as: (100 year useful life minus 30 year analysis period) divided by the 100 year useful life. This computation yields a multiplier of 0.7 which was applied to the total earthwork cost of the project. Working out this math for each component, the specific percentage of the individual major cost components included in the residual value for a 30-year analysis period was as follows: 100% of the real estate value; 70% of the earthwork; 60% of structural costs; 40% of road base work, and; 0% of pavement and other costs. Table 10 gives the residual values for each project.

DISCOUNT RATE

In benefit-cost analysis all benefits and costs are discounted back to a base year in which construction is assumed to begin, in this case, 2000. (In order to avoid the complicating effects of inflation, the analysis was conducted in constant 1996 dollars). This discounting is done, because if capital costs incurred in 2001, 2002, 2003, ... were financed and invested in 2000, the amount of the funds raised (and subsequently invested) would be less than the total amount needed. Discounting of benefits is done because of the "opportunity cost" associated with giving up benefits that might have been derived from other competing public investments.

TABLE 10
ESTIMATES OF RESIDUAL VALUE BY ALTERNATIVE
(in thousands)
US 31 Hamilton County Major Investment Study

Alternative Plan	Residual Value
Alternative 1	$87,256
Alternative 2	$95,379
Alternative 3	$100,346
Alternative 4	$71,914
Alternative 5	$93,544
Alternative 6	$64,208
Alternative 7	$77,677
TSM / Upgrade	$73,071
Upgrade 1	$111,778
Upgrade 2	$112,215

Traditionally, the benefit and cost streams are discounted at the same rate. Standard practice calls for the selection of a discount rate approximately equal to the "cost of capital" for a public investment without any allowance for inflation. Inflation is not included, since both benefits and costs are computed in constant dollars.

The problem is to select a discount rate that represents the cost of capital. The actual cost of capital for long-term public investments (excluding an allowance for inflation) is about 5%. This is a relatively low rate compared to private investments due to the tax exempt status of public sector financings. It is sometimes argued, however, that government should make investment decisions using the same criteria that the private sector uses. Using this line of reasoning espoused by the Office of Management and Budget, a higher discount rate is warranted.

The choice of a discount rate has a major impact on the outcome of the analysis, because of the timing of the benefits versus the timing of the costs. While the same discount rate is applied to both, the bulk of the costs are incurred early in the analysis period. On the other hand, the project's benefits accumulate over the entire economic life of the project; therefore, a substantial portion of the benefits are discounted more deeply than the costs. The higher the discount rate is the more the benefits are penalized as compared to the costs. In any event, due to the federal government's current preference for a higher discount rate, *a value of 7% has been selected for this analysis.*

ACCIDENT RATES & COSTS

User benefits associated with expected accident reductions attributable to the alternative were estimated by computing the probable number and type of accidents that would occur if the highway was built versus the number and type of accidents assuming the status quo (i.e., existing-plus-committed system). Average cost factors associated with each type of accident were then applied to the "build" versus "no build" conditions. The difference between the total accident costs with and without the improvements represents the safety benefits of the project.[14] Accident rates were presented in million vehicle-miles of travel by facility type and by average daily traffic volume range. Individual rates were applied for each of the three major classifications of accidents: fatalities, injuries and property damage only (PDO).

The accident cost factors used in the analysis are shown in Table 11.

TABLE 11
UNIT COST OF ACCIDENTS BY TYPE
US 31 Hamilton County Major Investment Study

Fatal Accidents[1]	$2,500,000
Injury Accidents[2]	$72,000
PDO Accidents[2]	$1,700

[1] *Highway Economic Requirements System* (HERS), 1991
[2] Urban Institute, 1991

These 1991 costs were inflated to January 1996 dollars in proportion to the ratio of the January 1996 versus the June 1991 Consumer Price Index (CPI). This translates into an annual cost inflation rate of about 3.1%.

[14] The accident rates used in this analysis were borrowed from Tables A-37 through A-39 in *Microcomputer Evaluation of Highway User Benefits* (Texas Transportation Institute, NCHRP 7-12, October, 1993). The source of the accident rates in these tables was *The Highway Economic Requirements System* (developed by Jack Faucett Associates for FHWA, USDOT, July, 1991).

VMT ADJUSTMENTS

Since the composition of travel demand changes on weekends, an investigation was undertaken to estimate the appropriate adjustment to VMT that should be made on weekends. This is a significant issue, because if total traffic volumes decrease on weekends, accident levels and total vehicle operating costs can be expected to decrease as well. Accordingly, it would not be appropriate to multiply average weekday VMT savings by 365 to estimate annual user benefits. (Note: The travel demand model used for this project simulates average weekday volumes.)

Average Saturday and Sunday travel as a percent of average weekday travel was estimated for urban highways at approximately 70%. When this fact is translated into an annual multiplier of average *weekday* VMT, a figure of 330.5 equivalent days-per-year is derived.[15]

VALUE OF TIME

A major component of the economic evaluation of any highway project relates to the amount of time that would be saved by motorists and commercial vehicles using the improved roadway system. This time savings is then multiplied by a monetary unit value-of-time. The time savings were calculated by comparing the cumulative vehicle-hours of travel (VHT) for autos and trucks under the modeled "no build" and "build" conditions. The unit values of time applied to the time savings can be found in Table 12.

TABLE 12
PER-HOUR UNIT VALUES OF TIME (in 1991 Dollars)[3]
US 31 Hamilton County Major Investment Study

Work-Related Person Trips	$9.75
Non-Work-Related Person Trips	$4.88
Single-Unit Truck Trips	$14.88
Combination Truck Trips	$19.50

[3] Source: *Highway Economic Requirements System* (HERS), 1991

These 1991 costs were then updated to January 1996 costs by way of the change in the Consumer Price Index.

---

[15] While there are several permanent counting stations on the state highway system throughout Indiana, there are no recent available reports breaking out traffic volumes by day of the week. Consequently, the decision was made to rely on data from Figure 2-9 (page 2-19) of the *1994 Highway Capacity Manual* (Transportation Research Board Special Report 209) to estimate Saturday and Sunday travel on the highway system. This reference is based on Minnesota data from the early 80s, but appears to be one of the very few sources readily available that addresses weekend travel. The reference provides daily traffic as a percent of total weekly traffic.

WORK VERSUS NON-WORK RELATED AUTO TRAVEL

In order to complete this analysis, the automobile vehicle-hours-of-travel (VHT) were divided into work-related and non-work-related trips, since people tend to value their time differently based on whether or not their trip is work-related. Moreover, the *vehicle*-hours of travel in each of these categories were then converted into *person*-hours of travel. An estimate of work-related versus non-work-related weekday auto travel was made at 47% versus 53%, respectively.[16]

Clearly, the composition of work versus non-work travel changes markedly on weekends. Unfortunately, there is very little empirical data available to help estimate *how much* it changes. Notwithstanding, the decision was made to reduce work-related auto trips 25 percentage points on weekends and increase non-work travel by the same amount.

In order to convert auto travel into person trips, auto occupancy rates from the Indianapolis sample of the National Personal Transportation Survey (NPTS) were weighted to reflect the work versus non-work related bifurcation of auto trips. This resulted in work versus non-work auto occupancy rates of 1.17 and 1.67, respectively.

VEHICLE OPERATING COSTS

The cost of operating a vehicle is influenced by a host of driving conditions as well as the type of vehicle itself. Since running speed serves as a good summary measure of driving conditions, operating costs were computed based on typical running speeds on each link of the transportation network. Consumption rates and costs specific to eleven speed ranges were calculated for each of three different classes of vehicles.

These vehicle classes were: (1) automobiles, (2) single-unit trucks, and (3) heavy-duty combination trucks. INDOT's Roadway Management Division was consulted to estimate the split between single-unit and combination trucks. That consultation resulted in a split of 15% and 85%, respectively.

Costs were computed for the five components of vehicle operating costs: (1) fuel, (2) engine oil, (3) tires, (4) maintenance, and (5) depreciation.[17] All five

---

[16] Two sources of data were referenced to estimate the proportion of work-related versus non-work related auto travel. The first source was the Kokomo Area Household Travel Demand Survey conducted in 1993 as part of the *US 31 / Howard County Corridor MIS*. This survey made the distinction between work and non-work related non-home based trips. The second source was Travel Estimation Techniques for Urban Planning (NCHRP Project 9-29, 1995).

[17] Cost rates per-thousand VMT were obtained from Tables B-1 through B-3 in *A Manual on User Benefit Analysis of Highway and Bus-Transit Improvements* (American Association of State Highway and Transportation Officials, 1977). These were then adjusted to 1995 dollars based on consumer and producer price indices specific to each cost component. Consumer price indices were used for all auto costs, as well as single-unit truck fuel and maintenance for both classes of truck. Producer price indices were utilized for all of the remaining truck cost components.

cost computations were computed individually for each link in the network. Table 13 summarizes cumulative vehicle operating costs per 1,000 vehicle-miles of travel by the three vehicle classes.

ESTIMATION OF SPEEDS AND TRAVEL TIMES

Integral to the measurement of both time benefits and vehicle operating benefits is the estimation of congested speeds. These speeds were estimated on a link-by-link basis using the standard volume-delay formulation utilized in Hamilton County's TRANPLAN travel demand model.[18]

Intersection-related delay was estimated based on the type of traffic control device present at each intersection (or assumed to be there by the year 2020) and the priority given to traffic on each intersection approach.[19]

TABLE 13
TOTAL OPERATING COSTS PER 1,000 VMT FOR SELECT SPEEDS
US 31 Hamilton County Major Investment Study

Speed	Autos	Single Unit Trucks	Heavy-Duty Trucks
20	$192.47	$471.03	$484.92
25	$189.87	$450.18	$468.31
30	$189.64	$438.75	$470.60
35	$191.49	$433.68	$483.80
40	$194.80	$452.65	$507.96
45	$198.10	$469.23	$543.72
50	$201.61	$487.00	$602.47
55	$206.89	$516.58	$644.51
60	$213.47	$547.72	$674.90
65	$221.93	$564.74	$699.57

[18] The equilibrium traffic assignment method was utilized for this study.

[19] Intersection delays were based on a publication entitled Delay/Volume Relations for Travel Forecasting Based Upon the 1985 Highway Capacity Manual (FHWA, January, 1991, page 30).

ESTIMATION OF TRUCK PERCENTAGES

Since truck percentages can vary widely throughout an urban transportation network, individual estimates were made on a link-by-link basis based on the road's functional classification and ADT. Four functional classification groupings were used in this phase of the analysis: Interstates and freeways, expressways and major arterials, minor arterials, and collectors/local roads. The estimation system is based on vehicle classification counts on a sample of Indiana highways and is reported as follows. (Data should be multiplied times 100 to convert to percentages.)

Interstates & Freeways	
ADT < 4,500	.325
4,500 # ADT < 60,000	.338801 - (3.1E-6 * ADT)
60,000 # ADT	.171601 - (6.0E-8 * ADT)

Expressways/Major Arterials	
ADT < 6,000	.3
6,000 # ADT < 16,000	.372712 - (1.2E-5 * ADT)
16,000 # ADT # 95,000	.1895 - 91.0E-6 * ADT)
95,000 < ADT	.0955

Minor Arterials	.1	Collectors/Locals	.05

BENEFIT-COST ANALYSIS RESULTS

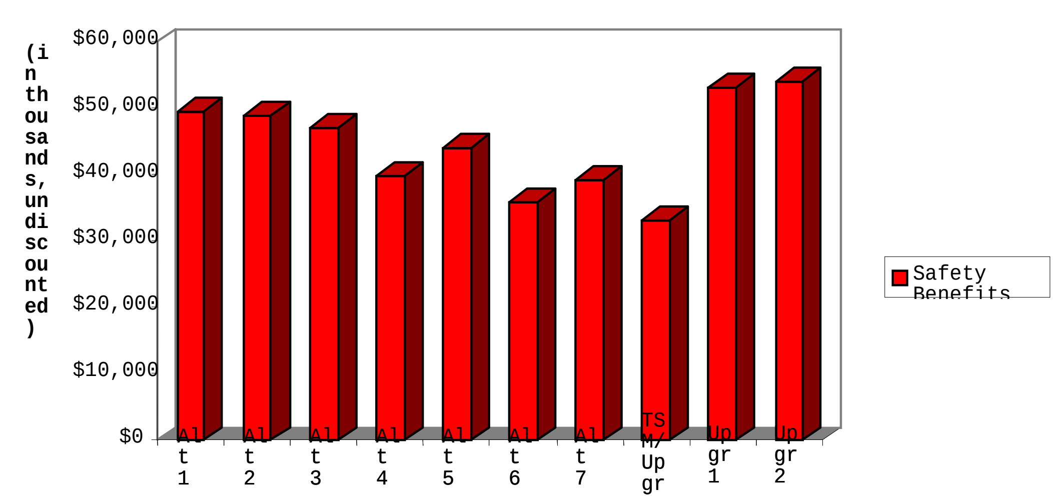
Safety, time and vehicle operating benefits for each of the five alternatives are summarized in Figures 9, 10, and 11, respectively. The benefits are reported in discounted 1996 dollars accumulated over the period between the hypothetical opening year (2005) and the end of the economic analysis period (2029).

SAFETY BENEFITS

As Figure 9 depicts, Upgrades 1 and 2 are essentially tied in terms of delivering the highest level of safety improvements. It is reasonable that the upgrades would perform well since all at-grade intersections along the US 31 mainline would be eliminated and all traffic on the highway would be subject to the lower accident rates typical of freeways versus other classes of roadways.

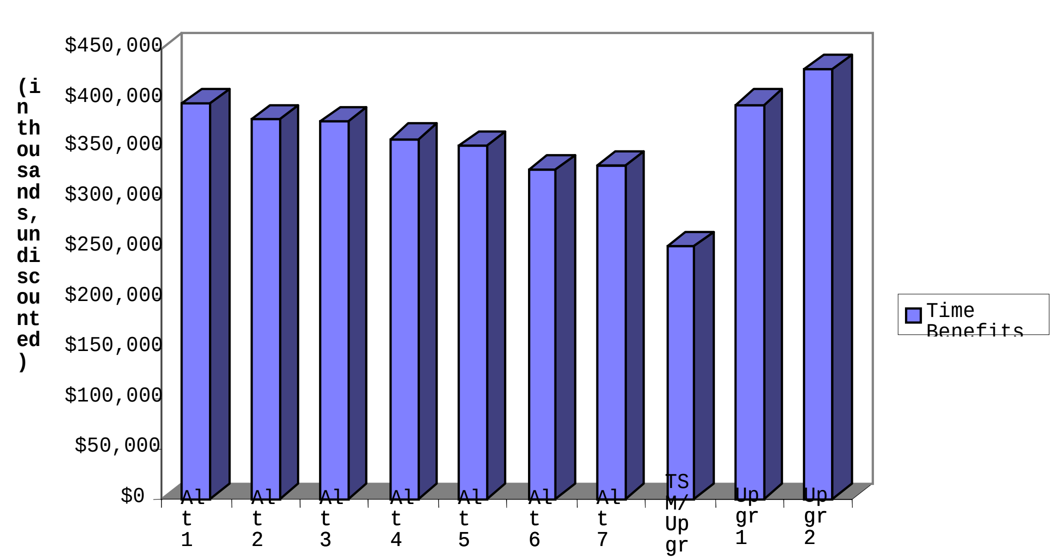
In the forecast year 2020, the reduction in the number of accidents resulting from construction of Upgrade 2 would be about 1,250 incidents-per-year. Of these about 5 would be fatal accidents, 476 injury accident, and the balance involving property damage only. In undiscounted 1996 dollars, an accident reduction of this magnitude would save motorists in 2020 almost $54,000,000-per-year.

FIGURE 9 SAFETY BENEFITS: YEAR 2020

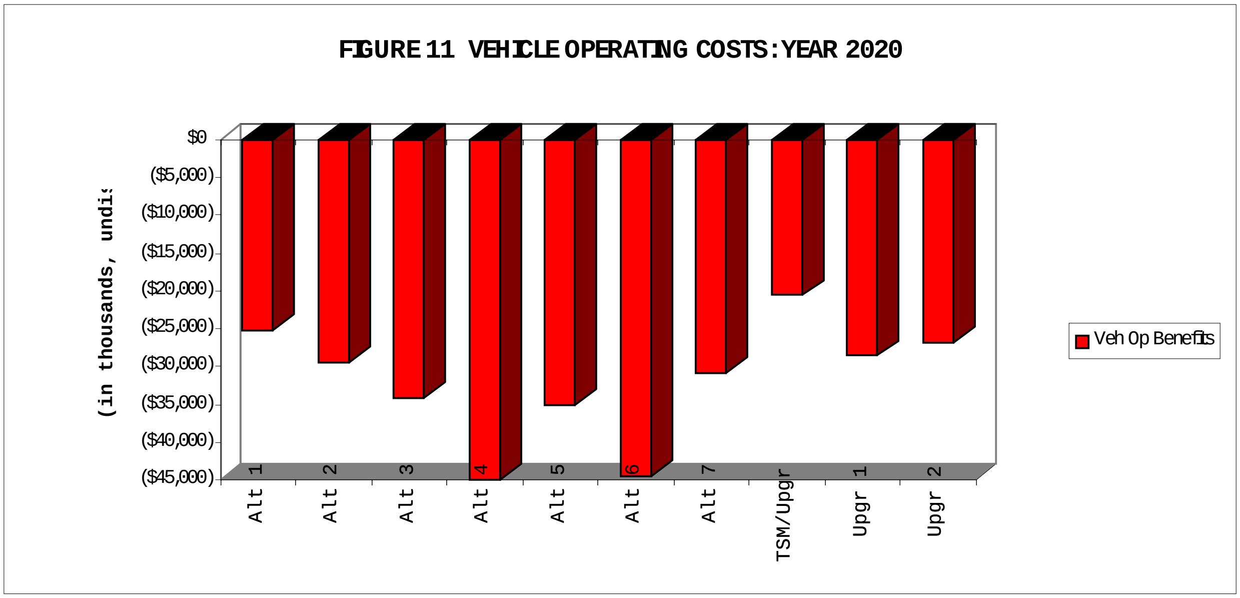


	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	Alt 6	Alt 7	TSM/Upgr	Upgr 1	Upgr 2
Safety Benefits	$49,492	$49,032	$47,216	$39,743	$43,962	$35,898	$39,174	$33,209	$53,181	$53,952

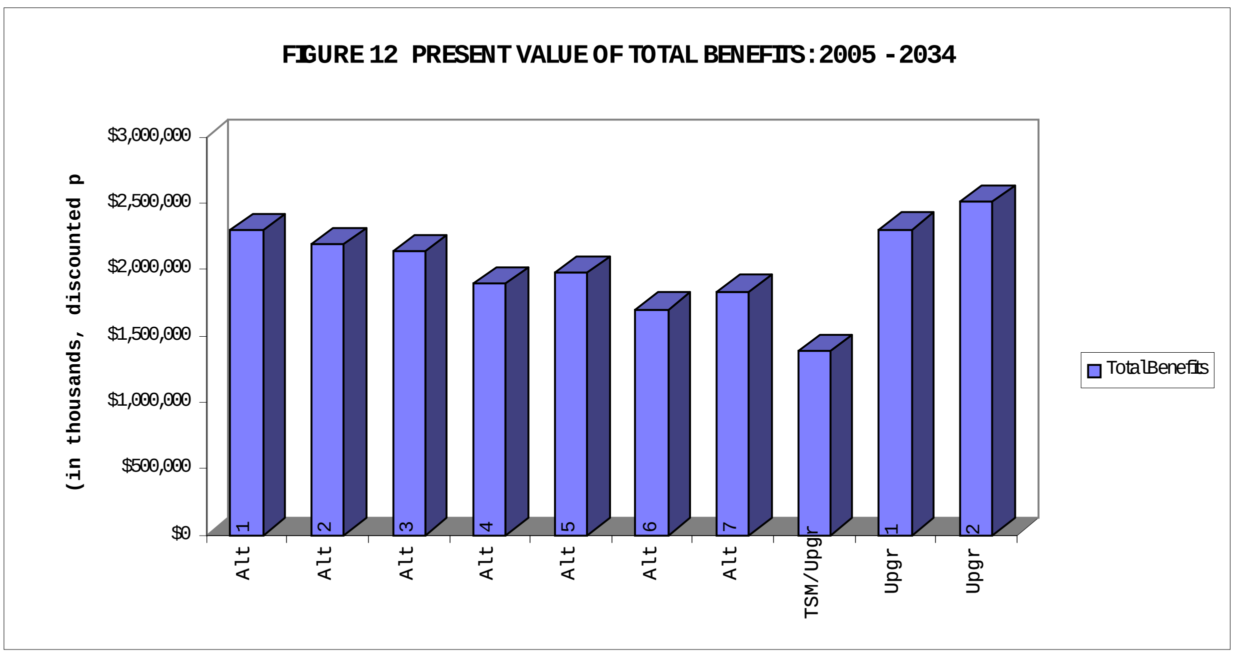
FIGURE 10 TIME SAVINGS BENEFITS: YEAR 2020



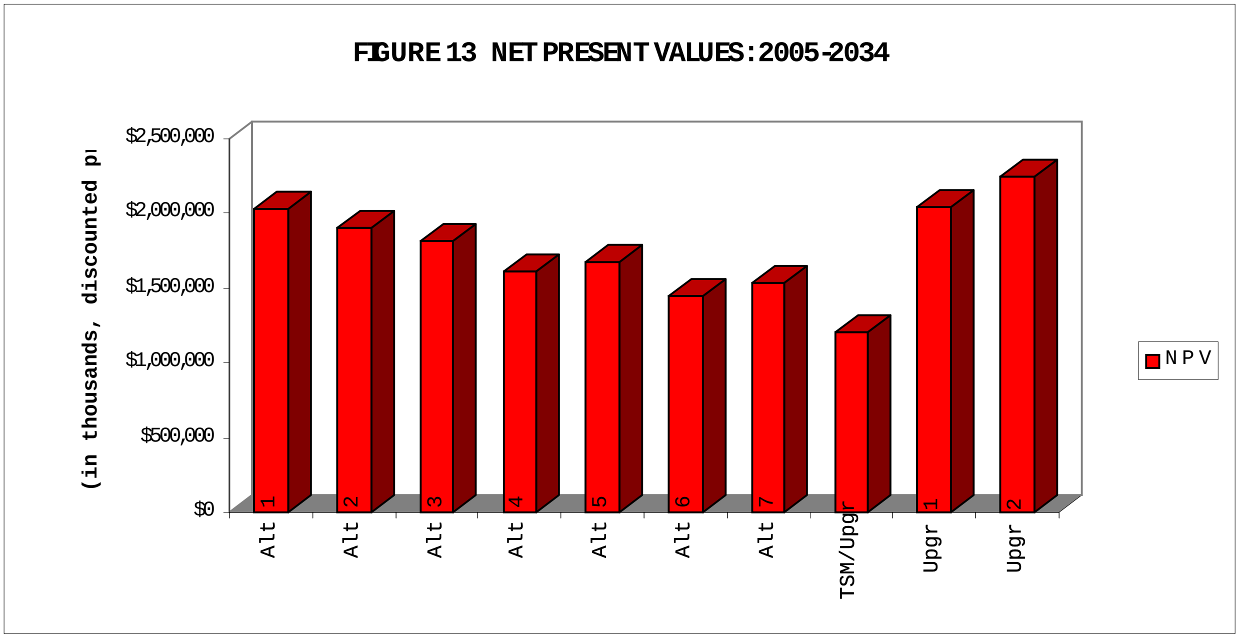
	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5	Alt 6	Alt 7	TSM/Upgr	Upgr 1	Upgr 2
Time Benefits	$394,080	$379,409	$377,633	$359,673	$351,889	$328,097	$332,031	$251,671	$393,840	$429,383



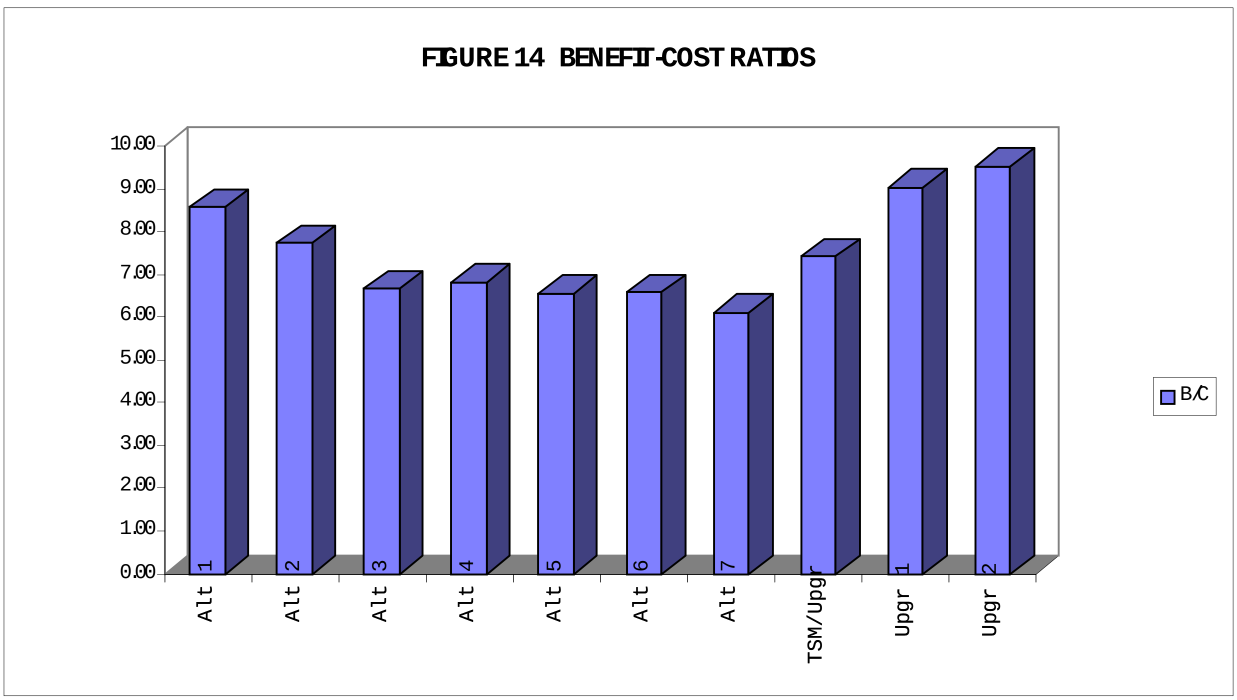
	Alt1	Alt2	Alt3	Alt4	Alt5	Alt6	Alt7	TSM/Upgr	Upgr1	Upgr2
Veh Op Benefits	($25,260)	($29,521)	($34,168)	($44,900)	($35,134)	($44,487)	($30,889)	($20,621)	($28,615)	($26,944)



	Alt1	Alt2	Alt3	Alt4	Alt5	Alt6	Alt7	TSM/Upgr	Upgr1	Upgr2
Total Benefits	$2,299,500	$2,193,600	$2,133,835	$1,892,381	$1,972,882	$1,703,778	$1,835,364	$1,387,777	$2,302,771	$2,511,522



	Alt1	Alt2	Alt3	Alt4	Alt5	Alt6	Alt7	TSM/Upgr	Upgr1	Upgr2
NPV	$2,031,161	$1,909,271	$1,814,114	$1,614,772	$1,671,695	$1,444,493	$1,535,209	$1,200,546	$2,048,042	$2,247,746



	Alt1	Alt2	Alt3	Alt4	Alt5	Alt6	Alt7	TSM/Upgr	Upgr1	Upgr2
B/C	8.57	7.72	6.67	6.82	6.55	6.57	6.12	7.41	9.04	9.52

Following not far behind are Alternatives 1 and 2. These would share the upgrade improvement south of 131st Street and divert a considerable amount of traffic from the unimproved portion of US 31 north of 131st Street. The TSM/Upgrade alternative would do the poorest job at delivering safety benefits, since it would leave so much traffic on local arterials and collectors subject to high accident rates.

TIME BENEFITS

While all of the alternatives would do an outstanding job in terms of providing travel time savings, the Upgrade 2 alternative (i.e., US 31 upgraded to a freeway plus an additional travel lane on SR 431) is the clear "winner". On an "average" weekday in 2020, the construction of Upgrade 2 would result in a savings of almost 97,400 vehicle-hours of travel. Allowing for differences in travel on weekends, this travel time savings would result in direct dollar savings to individuals and businesses of approximately $1,176,000-per-day (exclusive of vehicle operating cost changes). Annualized, this translates into about $429,382,000-per-year. Upgrade 1 and Alternative 1 are essentially tied in second place delivering about $394 million-per-year (undiscounted) in 2020. Ironically, the TSM/Upgrade alternative does the poorest job in terms of travel time savings. This is primarily because of the new signalized intersections that would have to be installed along Pennsylvania and Spring Mill Road to accommodate all of the traffic that would be diverted to these two roads. Generally speaking, the bypass alternatives are also comparatively poor performers.

VEHICLE OPERATING BENEFITS

The "downside" of many highway projects has to do with vehicle operating costs. When all the components of vehicle operation are included (not just fuel), the optimum speed for minimizing total costs is remarkably low. Consequently, any project that increases average speeds often increases overall operating costs (while reducing travel time costs). Accordingly, all of the alternatives would result in *negative vehicle operating "benefits" (i.e., net costs).* The alternative that generates the smallest increase is the TSM/Upgrade followed by Alternative 1. The TSM/Upgrade would increase operating costs about $20.6 million (undiscounted) in the year 2020. The Ditch Road bypass alternatives would increase operating costs the most, about $45 million.

PRESENT VALUE OF TOTAL BENEFITS

If costs were of no consideration, a rank-ordering of the cumulative discounted user benefits (safety, time, and vehicle operating) would provide a clear indication of the best alternatives. Although this is obviously not the case, a look at the present value of total benefits at least helps to identify which alternatives would do the best job. Figure 12 depicts the present value of total benefits for each alternative. A rank-ordering of the top five alternatives in terms of the present value of total benefits is as follows...

1st Place	Upgrade 2
2nd Place	Upgrade 1
3rd Place	Alternative 1
4th Place	Alternative 2
5th Place	Alternative 3

All of these alternates would deliver user benefits by the end of the analysis period (2029) of over $2.1 billion in constant 1996 dollars discounted at a rate of 7%. Upgrade 2 has a value of over $2.5 billion. Clearly, Upgrade 2 would provide the best benefits overall. Upgrade 1 and Alternative 1 (the shorter of the two Spring Mill Road alternates) are virtually tied in second place.

NET PRESENT VALUE

A strong argument can be made that the net present value of a project is a superior measurement of its cost effectiveness than the benefit-cost ratio. The definition of net present value is simply the present value of total benefits minus the present value of total costs. The benefit-cost ratio divides the benefits by the costs. In other words, the net present value represents the benefits that are "left over" after all costs have been subtracted out. If INDOT is willing to spend more money to get more benefits, the net present value is probably the best economic measurement to consider. As Figure 13 shows, a rank-ordering of the five best alternatives in terms of their net present value is...

1st Place	Upgrade 2
2nd Place	Upgrade 1
3rd Place	Alternative 1
4th Place	Alternative 2
5th Place	Alternative 3

Once again, the upgrade alternatives out perform all others. Moreover, the Spring Mill Road alternatives (1 and 2) are strong contenders. After all discounted costs are subtracted out, Upgrade 2 delivers almost $2.25 billion dollars of discounted benefits. Upgrade 1 and Alternative 1 generate net present values of $2.05 billion and $2.03 billion, respectively.

BENEFIT-COST RATIO

If INDOT'S capital investment goal is to maximize its return on investment while minimizing the size of the investment, the benefit-cost ratio is the most important measurement of economic feasibility. As Figure 14 suggests, a rank-ordering of the five best alternatives in terms of their benefit-cost ratios is...

1st Place	Upgrade 2
2nd Place	Upgrade 1
3rd Place	Alternative 1
4th Place	Alternative 2
5th Place	TSM / Upgrade

Interestingly, the TSM / Upgrade falls into 5th place, whereas its net present value and discounted total benefits would put it in last place. In other words, fairly significant benefits could be derived for a comparatively small price tag.

BENEFIT-COST CONCLUSIONS
In summary, the benefit- cost analysis points to at least two important facts. First, there is remarkable consistency between the various measures just described. They all point to upgrading US 31 to freeway standards as well as improving the capacity of SR 431. Regardless of whether or not capital funding is tight or widely available, the best course of action within the US 31 corridor is to implement Upgrade 2.

Secondly, there is almost no way to "go wrong". No matter which project is constructed, all of the benefit-cost ratios are remarkably high. Upgrade 2 delivers a ratio of 9.52. The lowest ratio is associated with Alternative 7 (the Towne Road alternative) and even its value is an impressive 6.12. The high rate of growth anticipated in Hamilton County over the first three decades of the next century assures unusually high benefit cost ratios; in other words, the high growth in benefits even in distant years offsets the deep discount.

TABLE 14
COMPARATIVE PERFORMANCE MEASURES: YEAR 2020
US 31 Hamilton County Major Investment Study

	Vehicle-Miles of Travel	Vehicle-Hours of Travel	System Performance Index[2]	Average Congested System Speed	# of US 31 Intersections with LOS E or F
Alternative 1	10,389,000	817,729	14.9	12.7	7
Alternative 2	10,410,000	821,056	14.7	12.7	7
Alternative 3	10,448,000	821,459	14.8	12.7	6
Alternative 4	10,582,000	825,533	13.4	12.8	9
Alternative 5	10,479,000	827,298	14.8	12.7	8
Alternative 6	10,603,000	832,695	13.6	12.7	9
Alternative 7	10,407,000	833,844	14.2	12.5	10
Upgrade 1	10,451,000	817,783	15.2	12.8	3
Upgrade 2	10,413,000	809,721	15.1	12.9	2
TSM / Upgrade	10,399,000	850,030	15.2	12.2	10

[1] The measurement of VHT includes an estimate of congestion and delay from intersection traffic control devices.
[2] The System Performance Index is a value equal to [1 / (VMT75+VMT99)]*100,000,000, where VMT75 and VMT99 equal VMT on links experiencing volume-to-capacity ratios > .75 and .99, respectively.

TRANSPORTATION PERFORMANCE MEASURES

While benefit-cost analysis is critically important in the selection and prioritization of projects, it is not the only factor that needs to be considered. It is possible for a project to have a relatively high benefit-cost ratio, while not solving the problem it was designed to solve. In this section, both system-wide measures as well as US 31-specific measures of performance will be considered.

SYSTEMWIDE PERFORMANCE MEASURES

The first four columns in Table 14 provide several measurements of the performance of the transportation system as a whole in the year 2020 for each alternative. It should be kept in mind that these statistics are measurements of *the entire road system* in the Hamilton County study area. Consequently, what appear to be small variations among the alternatives are actually not so small when it is understood that the differences are accounted for mostly by US 31-related traffic. The last column focuses on US 31, itself.

Vehicle-Miles of Travel A typical systems planning objective is to develop a plan that is efficient in terms of total vehicle-miles of travel (VMT). Using VMT as a system performance measure, The rank ordering of the five best alternatives is as follows...

1st Place	Alternative 1
2nd Place	TSM / Upgrade
3rd Place	Alternative 7
4th Place	Alternative 2
5th Place	Upgrade 2

Alternative 1 does the best job, with the TSM / Upgrade in a close second. Interestingly, Alternative 7 also provides good VMT efficiency because of its "bypass" effect. In fourth place is Alternative 2 with Upgrade 2 in fifth place. These five alternatives are very competitive with one another; they fall within a tight range of 13,000 VMT or about one tenth of 1% of the total VMT. After these five, the next most efficient alternative is 35,000 VMT higher and the numbers go up from there.

Congested Vehicle-Hours of Travel Vehicle-hours of travel (VHT) is another important measure of system efficiency, especially if the computation is a "true" measure that includes delay resulting from congestion-reduced speeds and traffic signals, stop signs, etc. The VHT listed in Table 14 does take these variables into account. Using congested VHT, the rank-ordering of the top five alternatives is as follows...

1st Place	Upgrade 2
2nd Place	Alternative 1

3rd Place	Upgrade 1
4th Place	Alternative 2
5th Place	Alternative 3

Upgrade 2 is the top performer in terms of congested VHT. It is about 1% less than the second place performer - Alternative 1. Upgrade 1 is virtually tied with Alternative 1.

System Performance Index The "system performance index" is a value that rises as congestion decreases. Its technical definition is...

$$[1 / (VMT75 + VMT99)] * 100{,}000{,}000$$

where,

VMT75 = VMT experiencing volume-to-capacity ratios > .75, and;
VMT99 = VMT experiencing volume-to-capacity ratios > .99.

In the volume-to-capacity or V/C ratios appearing in the formula, "volume" is defined as the modeled 2020 traffic and "capacity" is defined as a "practical LOS 'C'" service flow rate specific to each type of road and number of lanes. In this case, the capacity pertains to highway segments as opposed to intersection capacities. Note that this measure weighs V/C ratios with very high values (i.e., > .99) twice. Consequently, an alternative that eliminates these very congested links, will have a higher index than alternatives that do not.

The rank-ordering of alternatives based on the system performance index is as follows...

1st Place	Upgrade 1 & TSM/Upgrade
2nd Place	Upgrade 2
3rd Place	Alternative 1
4th Place	Alternative 5
5th Place	Alternative 3

Clearly, the upgrade alternatives as a group do better than all others. What Alternatives 1 and 5 have in common is their northern terminus near 196th Street (as opposed to 216th Street). Alternatives 5 and 3 each have Ditch Road as a common element. (It should be mentioned that Alternative 2 is an insignificant one-twentieth of a point less than Alternative 3).

Average Congested System Speed The average system speed is an obvious system performance measure. This measure does include delay time waiting at traffic control signals in the year 2020. (Note: Uncongested free flow speeds average between 32 and 34 mph.) The rank-ordering of alternatives based on average congested system speeds is as follows...

1st Place	Upgrade 2
2nd Place	Upgrade 1 & Alternative 4
3rd Place	Alternatives 1, 3, & 6
4th Place	Alternatives 2 & 5
5th Place	Alternative 7

These values are clustered very closely together, but Upgrade 2, Upgrade 1, and Alternative 4 are clearly superior to the rest.

Summary of System Performance Measures Table 15 sums the rankings of each alternative over the four system performance measures just discussed.[20] Using this method, the alternatives with the lowest scores are the best alternatives, while those with higher scores are the poor performers. On the basis of system performance measures, Upgrade 2 and Alternative 1 are tied for first place with a composite score of "9". In second place is Upgrade 1 with a score of 13.

TABLE 15
RANKINGS OF ALTERNATIVES BASED ON SYSTEM PERFORMANCE MEASURES
US 31 Hamilton County Major Investment Study

	Vehicle-Miles of Travel	Vehicle-Hours of Travel	System Performance Index	Average Congested System Speed	Additive Composite Rankings
Alternative 1	1	2	3	3	9
Alternative 2	4	4	6	4	18
Alternative 3	6	5	5	3	19
Alternative 4	9	6	4	2	21
Alternative 5	8	7	4	4	23
Alternative 6	10	8	8	3	29
Alternative 7	3	9	7	5	24
Upgrade 1	7	3	1	2	13
Upgrade 2	5	1	2	1	9
TSM / Upgrade	2	10	1	6	19

[20] The author realizes that summing ordinal data violates a fundamental rule of statistics. However, this is a common planning device and final recommendations will be based on numerous other considerations.

US 31 PERFORMANCE MEASURES

At this juncture, the focus shifts from system-wide performance to an evaluation of US 31, itself. While system measures are important, of at least equal importance is how well an alternative would do in terms of relieving congestion along US 31(as it is currently defined), since the statute mandating this study is expressly concerned about US 31. The following discussion reviews congestion on US 31 in terms of intersection levels-of-service and highway segment traffic volumes and levels of service.

US 31 Intersection Levels-of-Service While the system performance index discussed earlier relates to performance on segments of the roadway system, what is being discussed here is performance at intersections specifically along US 31. In the final analysis, most of the delay along US 31 occurs and will continue to occur at intersections. Consequently, it is important to focus attention on the intersections themselves. The last column in Table 14 enumerates the number of US 31 intersections that would operate during peak-hours at levels-of-service (LOS) "E" or "F" in the year 2020.

For the purposes of this table, it is assumed that access would be closed at US 31 and 103rd Street for all shared alignment and upgrade alternatives. If it were to remain open, then one more LOS "F" intersection count should be added to all shared alignment and upgrade alternatives. In either case, the top rank-orderings would remain the same except for the 4th and 5th places which would become tied.

The rank-ordering of alternatives from the fewest to the most intersections forecasted to exhibit poor levels-of-service is as follows...

1st Place	Upgrade 2
2nd Place	Upgrade 1
3rd Place	Alternatives 3
4th Place	Alternative 1 & 2
5th Place	Alternatives 5

In this case, Upgrades 1 and 2 out perform all the other alternatives. Moreover, there is a quantum leap between their performance and any of the others. Given Upgrade 2, there would only be 2 intersections along US 31 that would operate at LOS "E" or "F". Under Upgrade 1, there would be 3 such congested intersections. The next best is Alternative 3 with 6 substandard intersections.

It stands to reason that the upgrades would deliver better intersection LOSs, since they are the only alternatives that "lift" all traffic moving through an intersection over *all the cross-roads* and out of the intersection itself. In the case of the upgrades, only side street traffic and entering / exiting traffic would use the intersection. This frees up a tremendous amount of intersection capacity. Moreover, it makes sense that the other "shared alignment" alternatives would do better than the alternatives that can only divert traffic away from otherwise unimproved intersections along US 31.

Table 16
YEAR 2020 UPGRADE 2 LEVELS-OF-SERVICE AND DELAY AT US 31 INTERSECTIONS
US 31 Hamilton County Major Investment Study

Intersection	Average Delay	Level-of-Service
96th Street	48.1	E
I-465 East-Bound	40.0	D
I-465 West-Bound	>120	F
103rd Street	---	---
106th Street	24.4	C
111th Street	---	---
116th Street	24.7	C
Old Meridian Street	---	---
126th Street / Carmel Dr.	24.3	C
131st Street	---	---
136th / Guilford Road	37.0	D
Rangeline Road[1]	---	---
Greyhound Pass[1]	---	---
151st Street	24.8	C
Westfield Blvd.	---	---
156th Street	---	---
161st Street	19.1	C
169th Street	---	---
SR 32	34.2	D
181st Street	---	---
Blackburn Road	---	---
191st Street	14.8	B

[1] Part of interchange system with 146th Street. See Chapter 4 for more detail.
--- indicates either cross street would be closed or the mainline would overpass the cross street.

Table 16 lists the forecasted levels-of-service and average vehicle delay associated with Upgrade 2. Table 5 may be compared directly with Table 8 in Chapter 2, which provides the same data for the existing-plus-committed (i.e., "no build) system in the year 2020. A quick comparison shows that Upgrade 2 would reduce the number of deficient intersections along US 31 from a minimum of 17 to 2 intersections even while access is being eliminated at 11 locations. (Note that new access would be opened at 146th Street.)

US 31 Forecasted Traffic Volumes & Segment Levels-of-Service On the following pages a series of figures are provided that depict broad traffic volume patterns and levels of service in the year 2020. There is a separate figure for each of the ten "build" alternatives. Traffic/LOS data are recorded at the same locations on each figure to allow for easy comparison and to facilitate an understanding of the "big picture". (Note: In the following discussion, it may be helpful to refer back to Figures 3 and 6 in Chapter 2 which provide the exact same data for the existing and forecast year "No Build" scenario.)

Perhaps the most striking point to be made about Figure 15 (Alternative 1) is that US 31 can be expected to carry *substantially more traffic* if it is upgraded than it would carry if it is not. For example, a quick glance at the forecasted traffic volume on Figure 6 between 106th and 116th streets versus the volume in the same location on Figure 15 reveals that converting US 31 into an 8-lane freeway versus leaving it the way it is will increase traffic by approximately 40,000 ADT. The disturbing part of this message is that *either the unimproved or the improved facility would operate at LOS "F"* on this southern segment of US 31. Casual reference to the other "shared alignment" alternatives (i.e., 2, 3, and 5) confirms the same phenomenon: large volumes of traffic can be expected to divert from other congested parallel facilities if the highway is upgraded. The same pattern holds true for Upgrades 1 and 2.

This diversion can be confirmed by comparing traffic volumes on SR 431 (Keystone Avenue) in Figure 6 with those in Figure 15. Clearly, volumes drop by a substantial margin on SR 431 when US 31 is upgraded (unfortunately not enough to improve the level of service above "F" except north of 131st Street). Theoretically, if enough lanes are added to the freeway, the level of service would improve. However, this would come at a high cost both in terms of dollars and land use disruption.

Moving farther north along the freeway (in Figure 15), substantial volumes would be diverted to the new highway north of where it diverges from the existing alignment. Traffic on this new alignment located along Spring Mill Road would exceed 70,000 ADT between 146th and 161st streets and the LOS would improve to an acceptable "D". North of 161st, the LOS would get even better reaching "B" before it ties back into the existing alignment. However, "residual" traffic on the unimproved existing highway north of the point of divergence (around 131st Street) would still run quite high. Volumes would range between 35 - 48,000 ADT up to SR 32. These are slightly higher than today's volumes which already operate at LOS "F" between 151st and SR 32.

An almost identical pattern emerges on Alternative 2 (Figure 16). The only substantive difference is that the freeway north of 131st Street would divert less traffic because it tie into the existing highway farther north. This has the effect of eliminating some trips from the opportunity to use the freeway. Accordingly, Alternative 2 is not quite as helpful as Alternative 1.

Figures 17 and 19 display forecasted volumes for the two "shared alignment" alternatives that use Ditch Road north of 146th Street. These are Alternatives 3 and 5. South of 131st Street on the existing alignment, traffic volumes exceed 100,000 ADT and follow the same pattern as Alternative 1 and 2. Both alternatives, however, would carry fewer vehicles-per-day than Alternative 1 and 2 north of the divergence point. Instead of volumes in the 70,000 range between 146th and 161st streets, Alternatives 3 and 5 would carry about 56,000 ADT on the same segment of highway. This is reasonable in light of the fact that Ditch Road is farther away from the existing alignment than Spring Mill.

Interestingly, unlike Alternatives 1 and 2, the location of the northern terminus has very little effect on the volume of traffic that the new highway would carry north 131st Street. It does, however, have a marginal effect on how much of that traffic is being diverted from the existing highway. Alternative 3 with its far north terminus diverts slightly less traffic away from the existing highway north of 161st Street. On the other hand, since Alternative 3 would divert traffic off a highly congested highway to a point farther north than Alternative 5, if the choice came down to one of these two improvements, the benefit-cost analysis suggests that Alternative 3 would be the better choice. South of 161st Street, the residual volumes on existing US 31 are virtually identical and in both cases, the levels of service remain at "F".

Figures 18 and 20 depict forecasted conditions for Alternatives 4 and 6. Alternative 4 is the Ditch Road bypass with the far northern terminus near SR 38. Alternative 6 is the same as Alternative 4 except that its northern terminus is near 196th Street. The obvious advantage to these "new alignment" alternatives is that they both divert traffic off of the segment of US 31 south of the SR 431 merge. Moreover, they do not carry enough traffic themselves to produce a level-of-service poorer than "D". In most locations, it is "C" or better. On existing US 31, instead of volumes around 130,000 ADT typical of the shared alignment and upgrade alternatives south of 116th Street, traffic would be in the 70-80,000 ADT range. Unfortunately, even at these reduced volumes, without adding capacity to the existing alignment, these Ditch Road bypass corridors *do not divert enough traffic* to improve levels-of-service above "F" anywhere between I-465 and SR 32.

An analysis of the diversionary potential of Alternative 4 between SR 431 and SR 32 shows that the bypass is a little more helpful than Alternative 3 (i.e.,

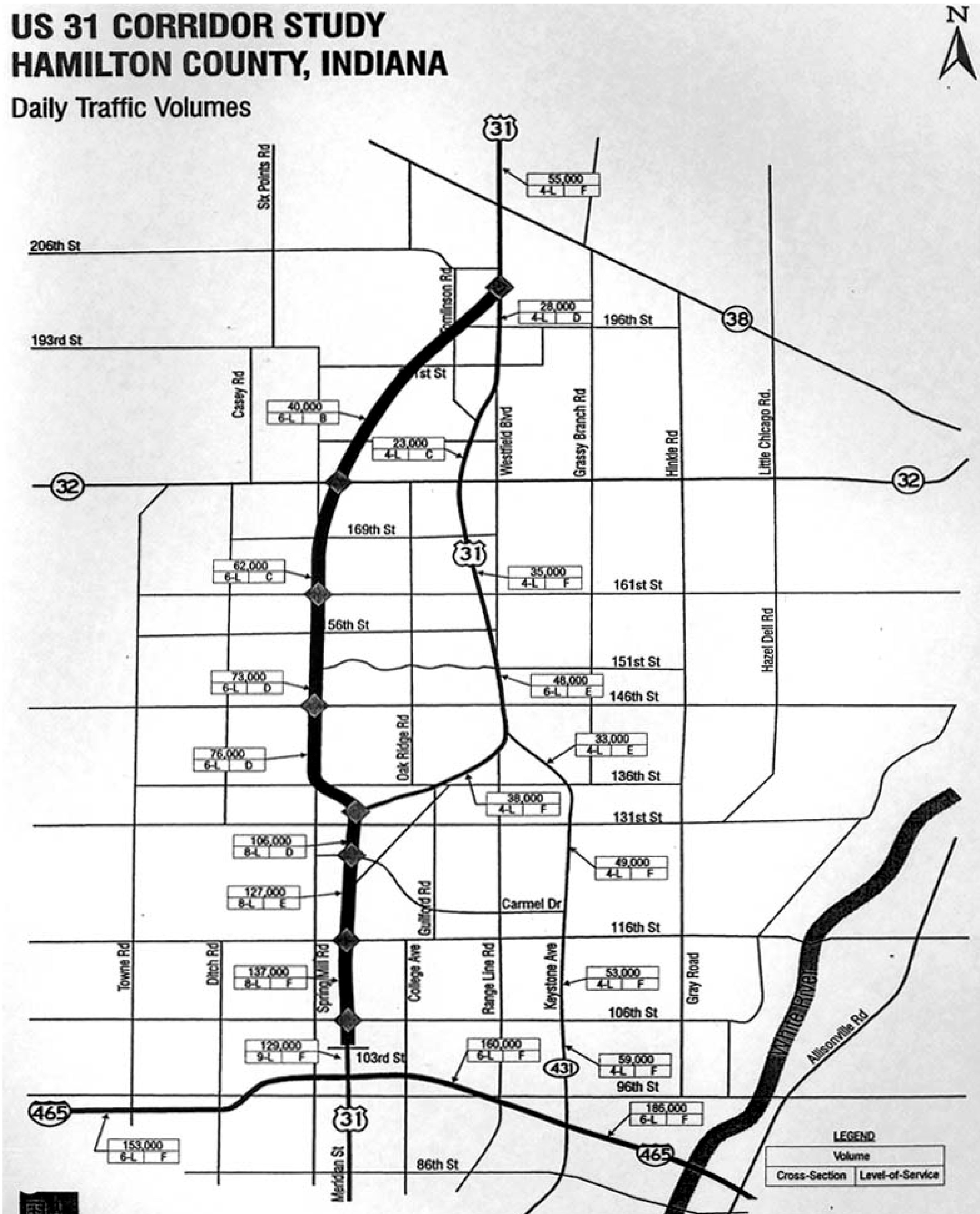


Figure 15
Year 2020 Traffic Volumes & Levels-of-Service
Alternative 1

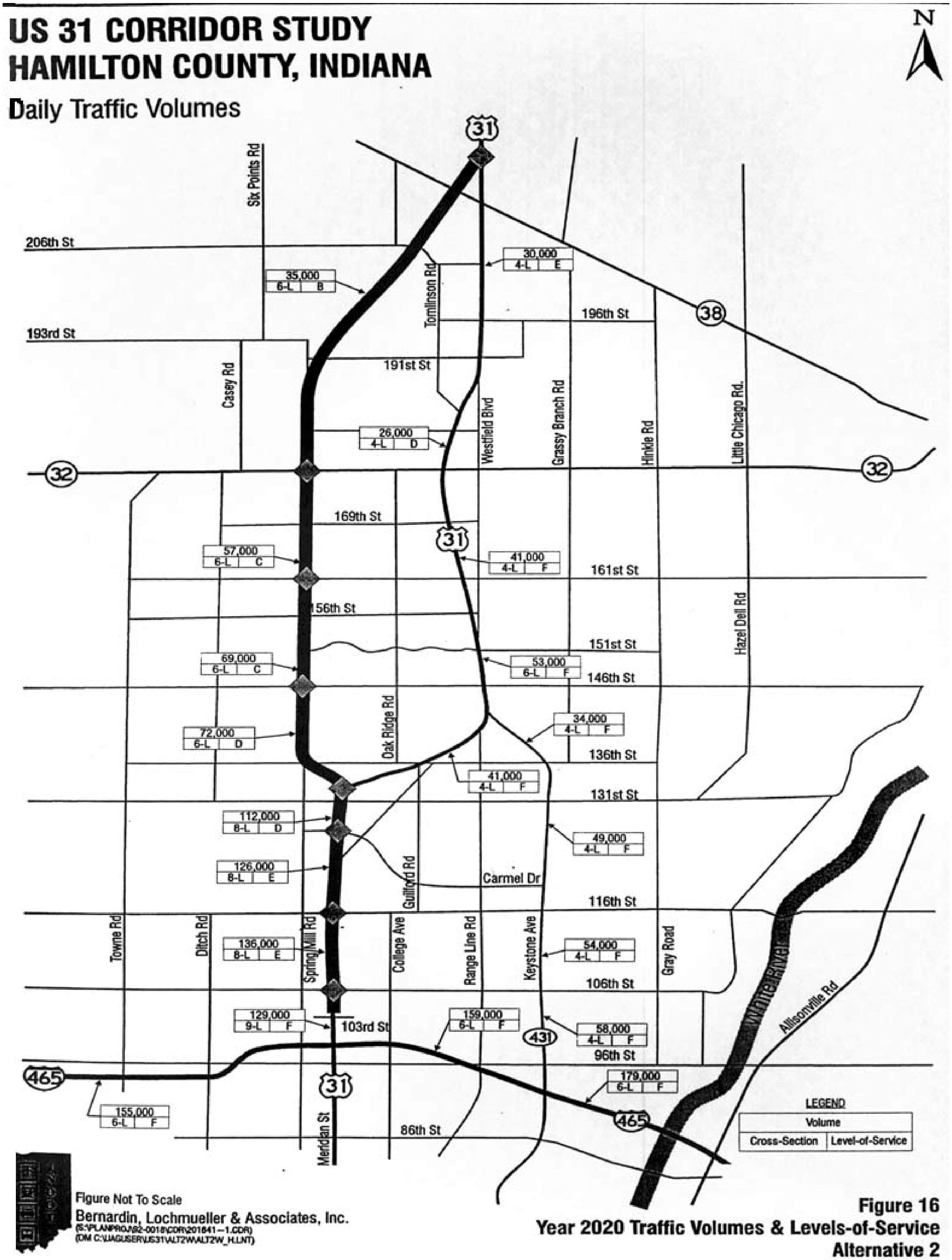


Figure 16
Year 2020 Traffic Volumes & Levels-of-Service
Alternative 2

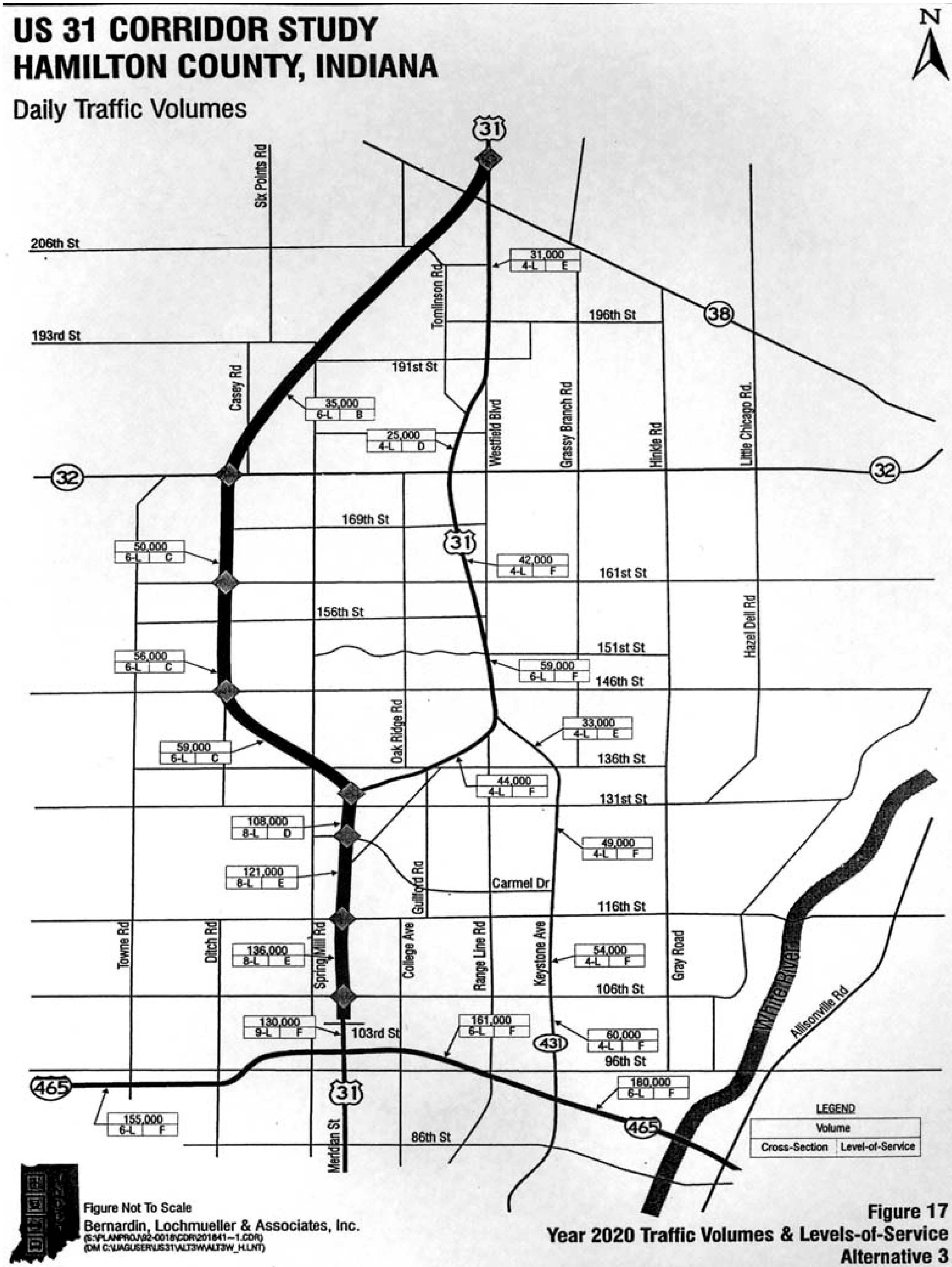


Figure 17
Year 2020 Traffic Volumes & Levels-of-Service
Alternative 3

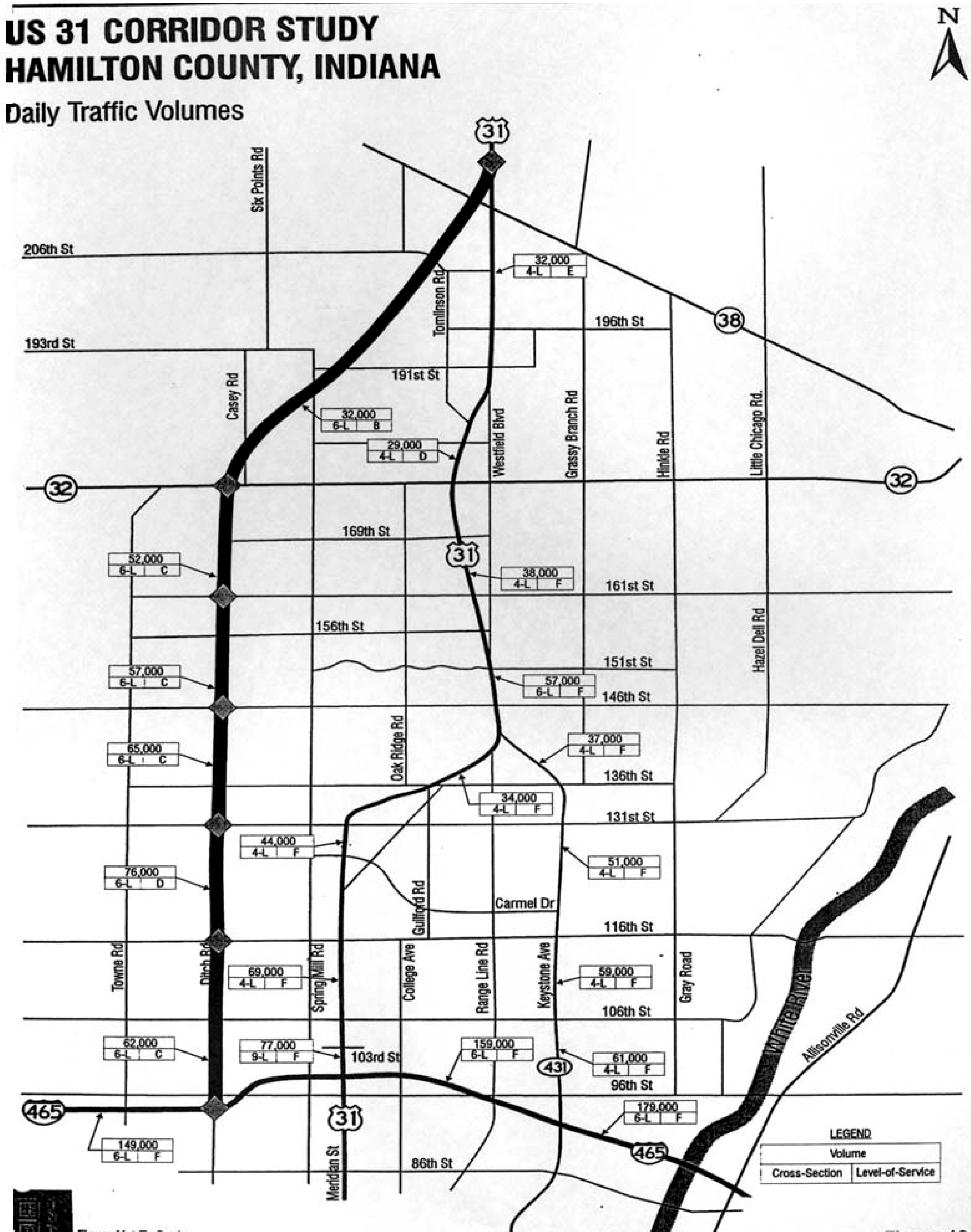


Figure 18
Year 2020 Traffic Volumes & Levels-of-Service
Alternative 4

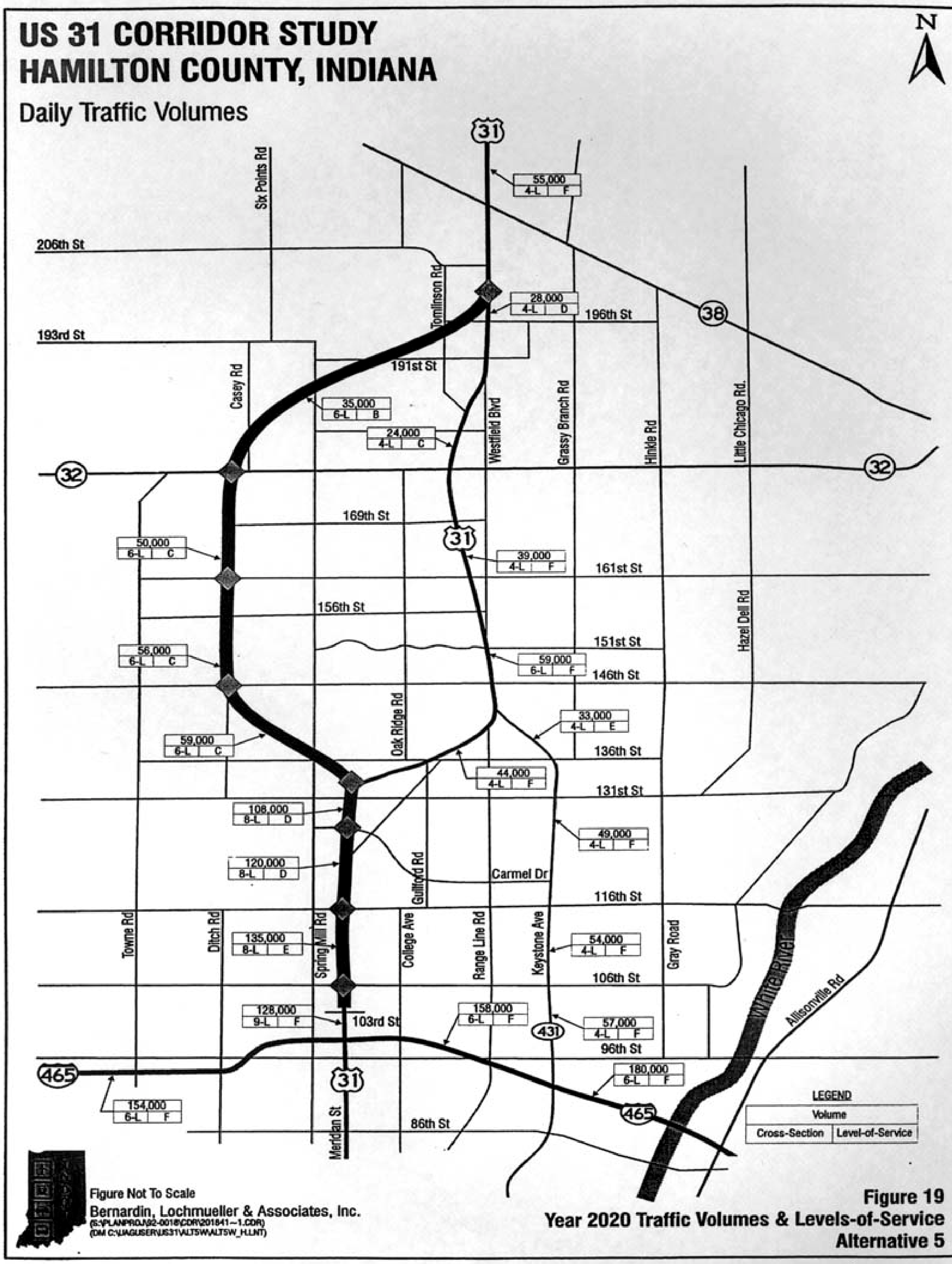


Figure 19
Year 2020 Traffic Volumes & Levels-of-Service
Alternative 5

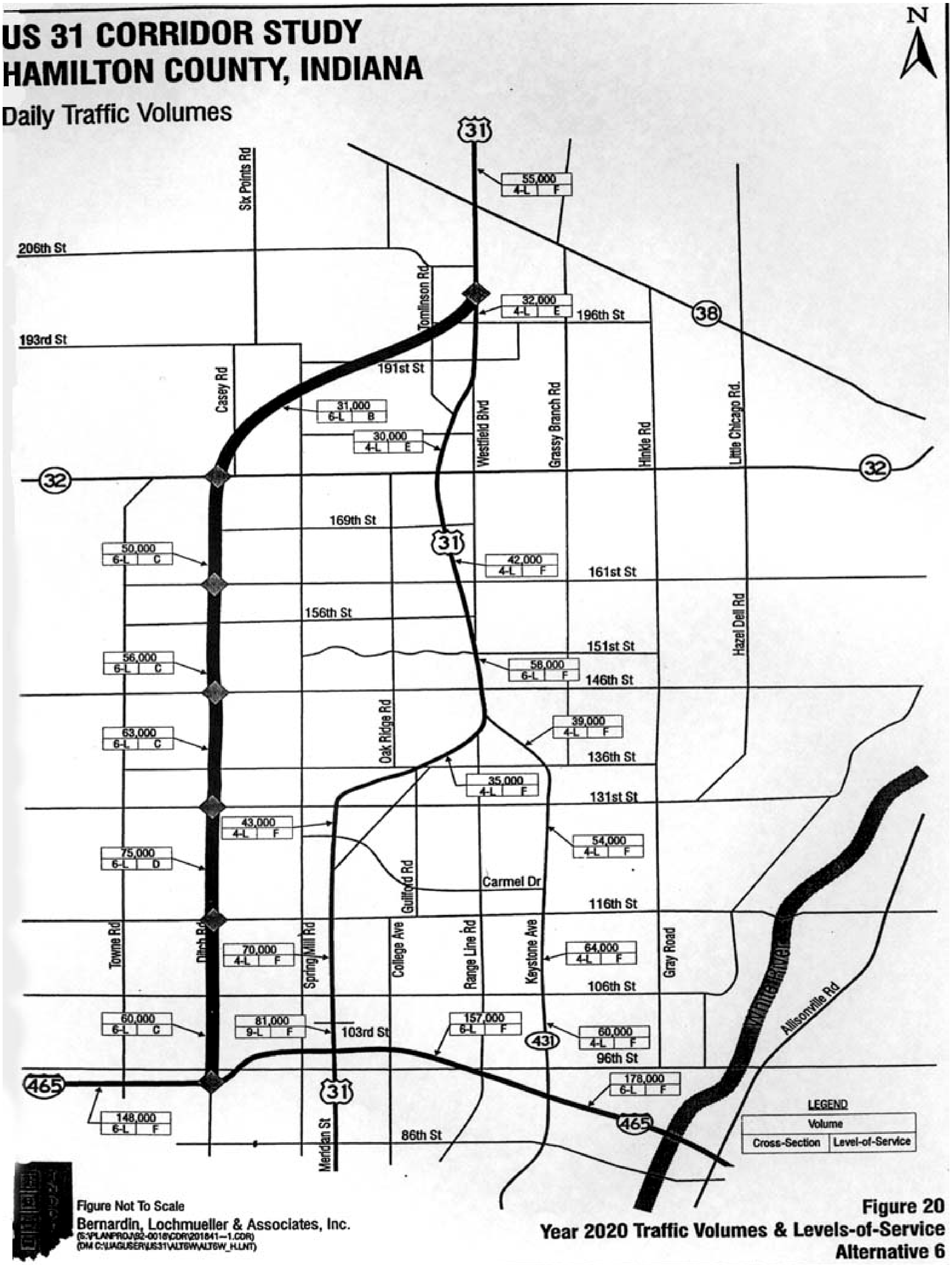


Figure 20
Year 2020 Traffic Volumes & Levels-of-Service
Alternative 6

US 31 CORRIDOR STUDY
HAMILTON COUNTY, INDIANA

Daily Traffic Volumes

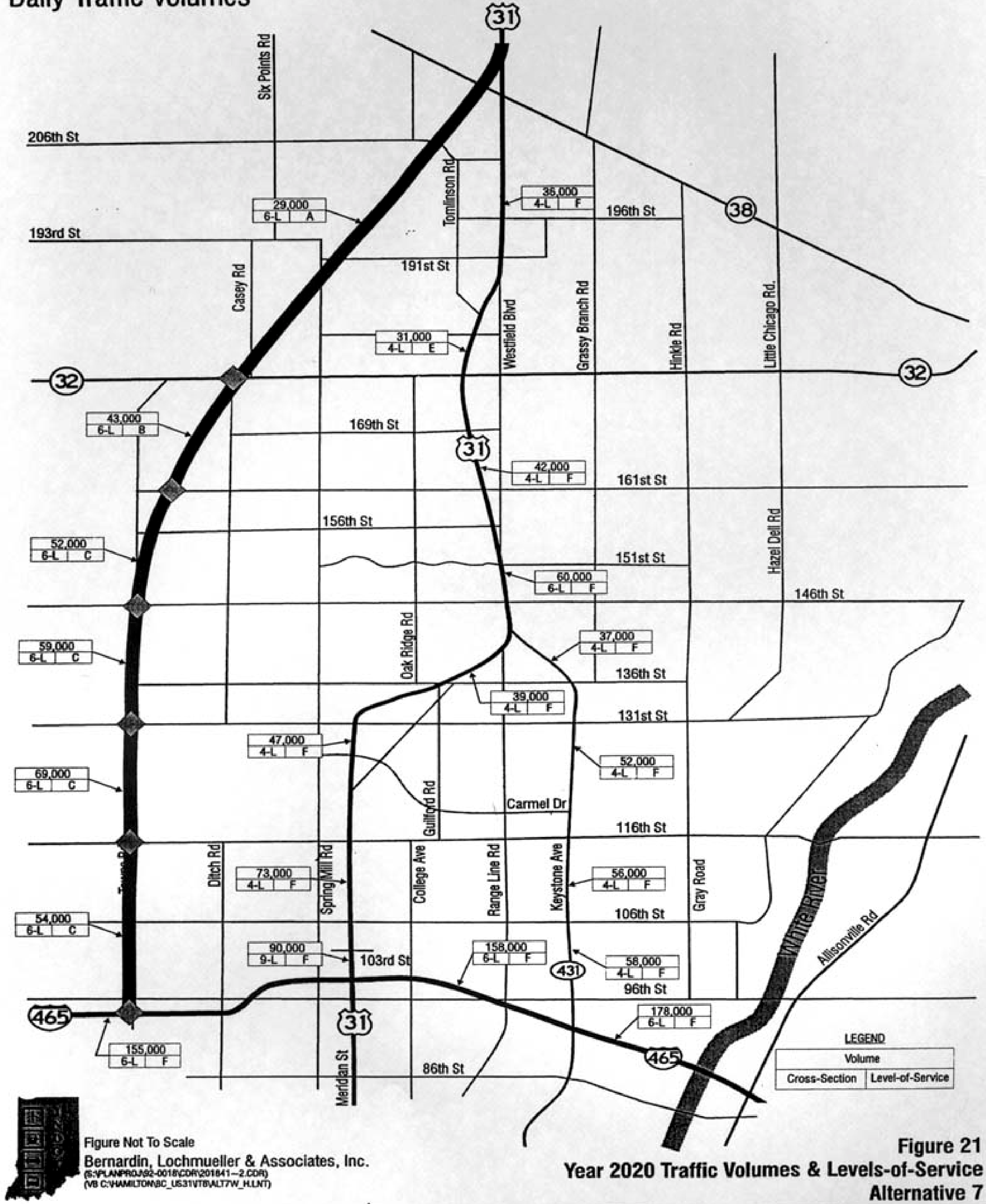


Figure Not To Scale
Bernardin, Lochmueller & Associates, Inc.

Figure 21
Year 2020 Traffic Volumes & Levels-of-Service
Alternative 7

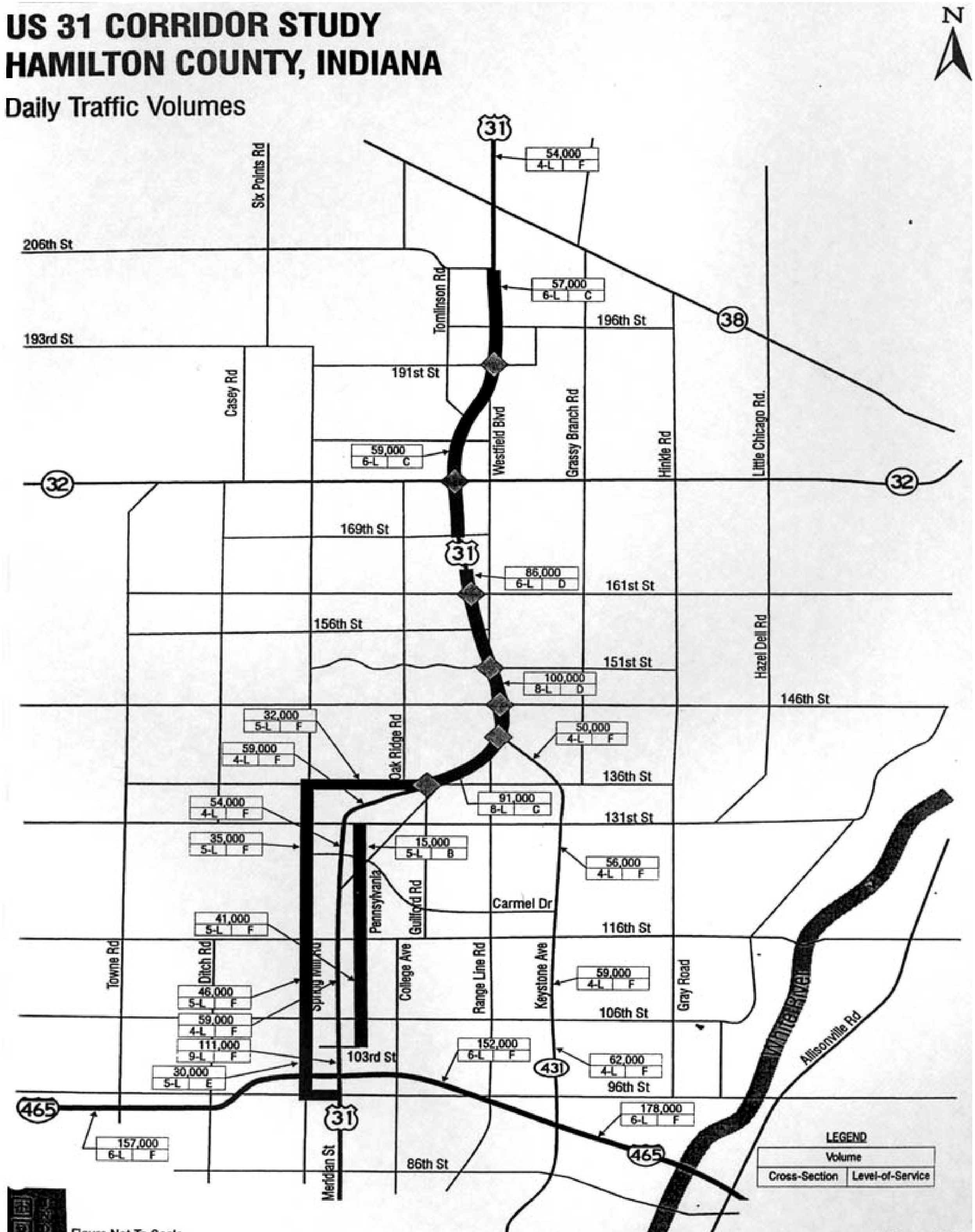


Figure 22
Year 2020 Traffic Volumes & Levels-of-Service
TSM Upgrade Alternative

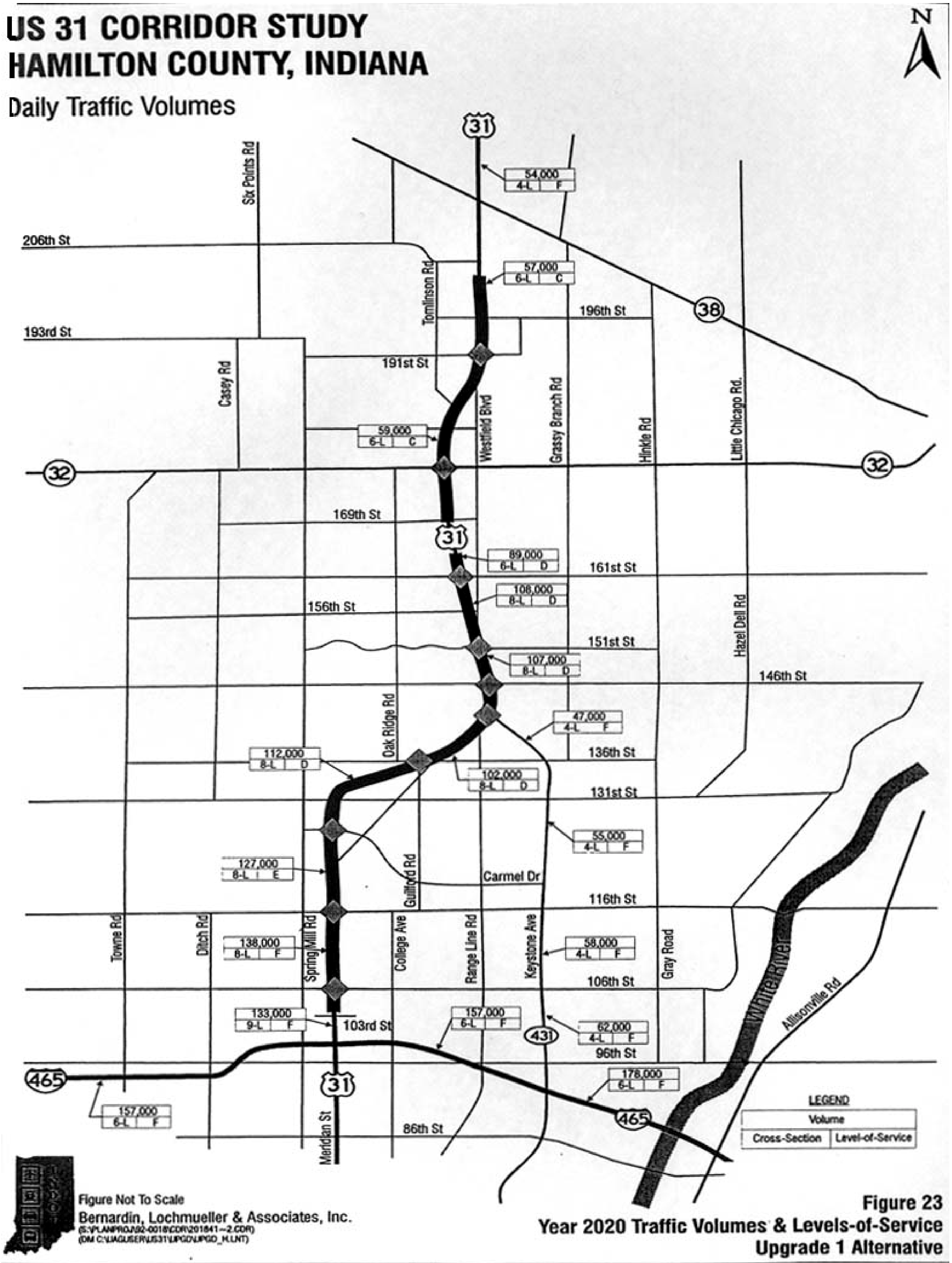


Figure 23
Year 2020 Traffic Volumes & Levels-of-Service
Upgrade 1 Alternative

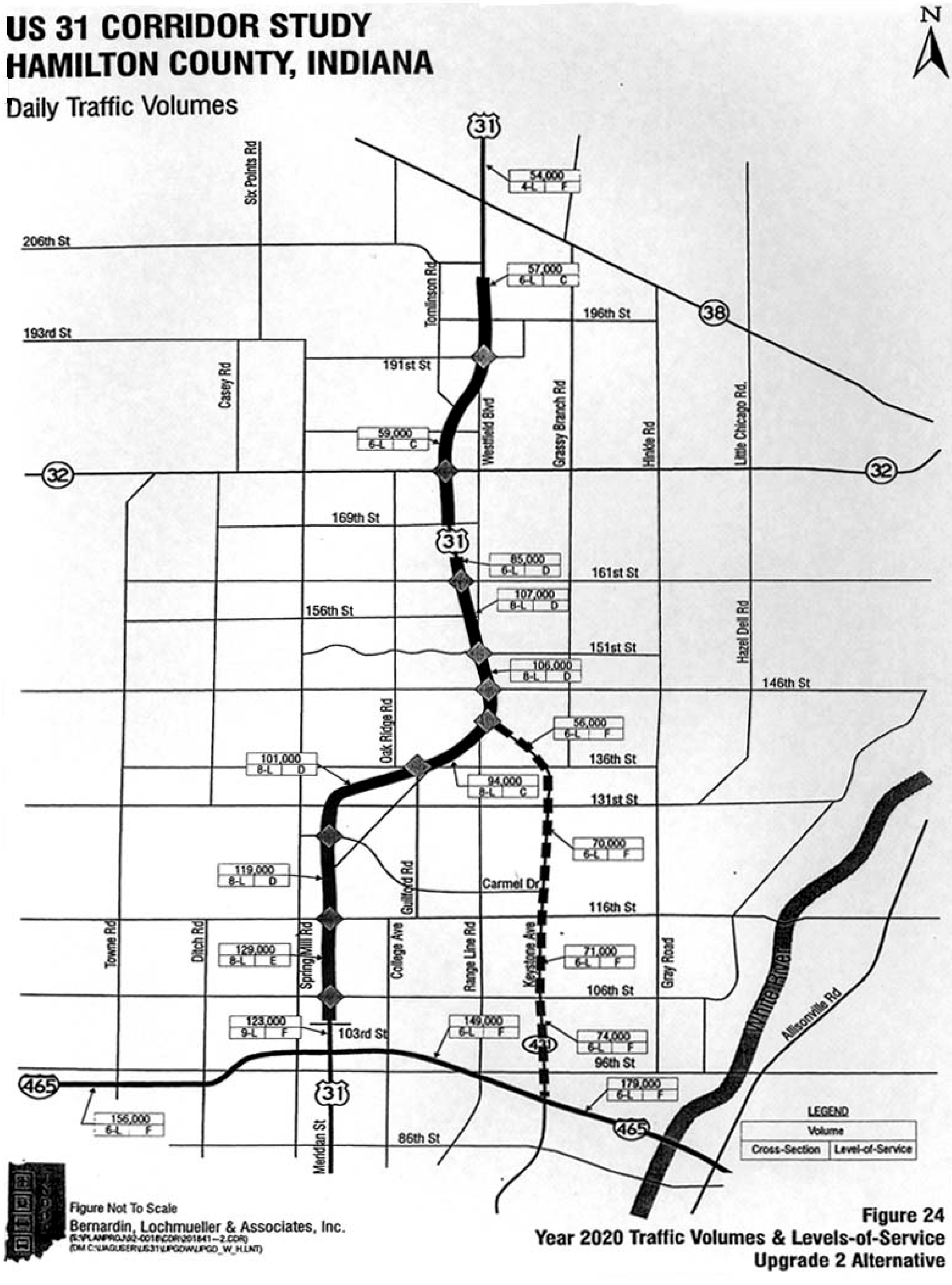


Figure 24
Year 2020 Traffic Volumes & Levels-of-Service
Upgrade 2 Alternative

Ditch Road shared alignment with far north terminus), but less helpful north of SR 32. It is generally less helpful than Alternative 2 (i.e., Spring Mill Road shared alignment with far north terminus) any place north of SR 431.

North of SR 431, Alternative 6 (i.e., Ditch Road bypass with northern terminus near 196th Street) is fairly consistently less helpful than Alternative 5 (i.e., Ditch Road shared alignment with northern terminus near 196th Street) and decidedly less helpful than Alternative 1 (i.e., Spring Mill Road shared alignment with northern terminus near 196th Street). Generally speaking, Alternative 4 performs better than Alternative 6.

Alternative 7 is the Towne Road bypass and can be found in Figure 21. For purposes of comparison, it is similar to the Alternative 4 (i.e., the Ditch Road bypass shown in Figure 18). A quick comparison reveals that it consistently carries less traffic than either Ditch Road bypass (volumes range between 29 - 60,000 ADT) and predictably it does a poorer job of diverting traffic away from the existing alignment, since it is located one mile farther west than Ditch Road.

Figure 22 depicts traffic conditions for the TSM / Upgrade alternative. The results are mixed. For example, between 106th and 116th streets, the widening of Spring Mill and Pennsylvania serve to reduce traffic on US 31 more than any other alternative (i.e., 59,000 ADT versus 69,000 under Alternative 4). However, between Carmel Drive and 131st Street volumes on US 31 would be about 54,000 ADT versus 44,000 under Alternative 4. South of 103rd US 31 would carry 111,000 versus 77,000 assuming Alternative 4. Moreover, the good that would be done on US 31 would come at a high price on Spring Mill and Pennsylvania. Even assuming 4 lanes with a continuous center turn lane, these roads would typically carry between 40 - 60,000 ADT and operate at a level-of-service "F".

As is true of the other upgrade alternatives, the "upgrade" portion of the concept would work well. Volumes north of 146th Street would vary between 57 - 100,000 ADT with associated levels-of-service of "C" and "D".

Upgrades 1 and 2 can be found in Figures 23 and 24, respectively. The pertinent question regarding these concepts is whether or not it is feasible to upgrade the existing highway to a facility that has enough capacity to handle not only its own projected growth, but also the traffic from parallel facilities that would be diverted to it. A quick glance at Figures 23 reveals that the answer to this question is "yes" except south of 116th Street. These ultra-high volumes prompted the recognition that the entire problem cannot be practically resolved on US 31 itself. Accordingly, in Upgrade 2 an additional travel lane in each direction is added to SR 431 to siphon off some of the expected demand on US 31 (a concept consistent with the Indianapolis Long Range Plan). This has the desired effect of bringing the LOS well within the "E" range.

Unfortunately, an LOS of "F" still remains south of 103rd Street. Even if the 103rd Street intersection is closed, the traffic signals at I-465 would result in a bottleneck for this short distance. (An addition to the Upgrade 2 concept that could eliminate this problem is discussed in Chapter 4.)

TRANSPORTATION PERFORMANCE CONCLUSIONS

When all is said and done, both the systemwide performance measures and the forecasted US 31 traffic and levels-of-service suggest that of the ten alternatives studied, Upgrade 2 is the preferred concept and should be implemented.

HUMAN & ENVIRONMENTAL CONCERNS

In addition to benefit-cost analysis and transportation performance measures, the third criterion used for evaluating the build alternatives is the whole range of human and environmental issues that relate to highway development.

EXPRESSED CONCERNS

A critical aspect of this study has been to monitor the opinions of the general public. Those opinions have been expressed in public meetings as well as telephone communications and correspondence.

One very strong message that has been communicated through all of these media has been the desire for the US 31 corridor improvement to be constructed along the existing alignment. Most correspondence has come from residents and developers with interest in the Spring Mill Road and Ditch Road corridors. Both of these areas are presently developing at a "break neck" pace and the potential for disruption by a new freeway corridor is very threatening.

Prior to the July 9, 1996 public information meeting, over 200 pieces of correspondence or written statements were received either by INDOT or the consultant. While there were numerous individual concerns expressed, two separate but related themes came through in every single statement. 108 statements expressly supported the upgrading of US 31 on its existing alignment. 103 specifically objected to the development of any non-upgrade alternative.

Land use studies of the alternative corridors (performed in 1996) help to document the concern. If land acquisition for Upgrade alternative 1 or 2 were to begin immediately, 53 homes would have to be purchased. Among the alternatives studied, the next lowest number of affected homes would be 60 associated with Alternative 5. The highest potential number is 152 associated with Alternative 2.

If the land acquisition was delayed about ten years (which is a very real possibility), local planning officials have estimated that by 2005 about 83 households would have to be relocated under one of the Upgrade alternatives.

The next lowest number is estimated at 305 households related to Alternative 2 with the highest potential number being 430 households associated with Alternative 4. Clearly, upgrading US 31 offers the least disruptive course of action among the alternatives considered.

ENVIRONMENTAL ISSUES

As a part of this major investment study, a thorough environmental overview was conducted of the upgrade alternatives and western alternatives 1 - 6. Alternative 7 was not specifically reviewed, since it was possible to eliminate it from further study on the basis of its benefit-cost and transportation performance measures. (The environmental overview is a separate volume of the MIS.) A summary table of comparative data excerpted from the Environmental Overview may be found in Appendix 3. A few highlights of the environmental overview are as follows ...

From approximately 25 to 338 acres (10 to 137 hectares) of crop and grazing land would be required for right-of-way (R/W) depending on the alternative chosen.

There are essentially no geological issues irrespective of the alternative.

Ecological issues are modest. Depending on the alternative, 2 to 10 streams would be crossed and 1 to 3 floodplains would be crossed. Forested land area that would be impacted ranges from approximately 12 to 49 acres (5 to 20 hectares). Estimates of potential wetland impacts range from less than 2.5 to 12 acres (1 to 5 hectares). Alternatives 2, 3, and 4 affect 1 classified forest and wildlife area.

One or two historical structure(s) and/or properties are within the right-of-way (R/W) of each alternative. Up to 3 are adjacent to the R/W.

There are no Superfund or CERCLIS sites or landfills in the R/W of any of the alternatives. There are as many as 7 RCRA sites and 10 underground storage tanks in or near the R/W of the Upgrade.

There are very few species of plants, fishes, birds, reptiles, mussels or mammals with a likelihood of being found within the study area that are listed either by the federal government or the state as being threatened, endangered or specially listed.

The R/W of the Upgrade could potentially affect one city/county park as well as a small amount of Washington Elementary and Westfield Washington High School property.

Pedestrian and bicyclist safety would likely be enhanced by any of the alternatives since the highway would lessen vehicular traffic on county roads. The CSX railroad and abandoned railroad grade south of SR 32 have been proposed as "Rails-to-Trails" corridors in Hamilton County. All of the alternatives could be designed to keep these corridors open.

A private airfield is located in the alignment of Alternatives 1 and 2.

AIR QUALITY IMPACTS

An air quality analysis was conducted to determine the impacts of Upgrade 2 on regional mobile source emissions. PPAQ software was connected with MOBILE-5 and an inventory of emissions was computed for the Hamilton County study area for the year 2020 for the existing-plus-committed network and the Upgrade 2 network. The analysis resulted in a small (but growing) improvement in air quality assuming Upgrade 2 is constructed. The modeled reduction in emissions for 1996 and 2020 are found in Table 17.

TABLE 17
HAMILTON COUNTY STUDY AREA REDUCTIONS IN MOBILE SOURCE EMISSIONS FOR NOx, CO, AND VOC ASSOCIATED WITH UPGRADE 2: 1996 AND 2020
US 31 Hamilton County Major Investment Study

	NOx (kg)	CO (kg)	VOC (kg)
1996	110	760	80
2020	1,500	10,000	1,200

This analysis assumed July temperatures. No winter analysis was conducted, though winter emissions in Indiana are not typically a problem. The model assumed national distributions of input values that were not locally available.

HUMAN & ENVIRONMENTAL CONCLUSIONS

Environmental impacts inevitably occur as a result of any large transportation project. However, based on the environmental studies associated with the MIS, it would appear that there are no environmental impacts that would require extraordinary mitigation measures.

There is strong public sentiment in favor of upgrading US 31 versus any other "build" alternative and there does not appear to be any technical or environmental reason that would warrant overriding the public's desires on this issue. These conclusions, however, are tentative and subject to verification based on a complete environmental analysis conducted pursuant to the National Environmental Protection Act.

TRANSIT, HOV, AND "NON-BUILD" ALTERNATIVES

Also evaluated in this study were several additional approaches to improving transportation in the US 31 corridor. These approaches include the introduction of public transit, high-occupancy vehicle (HOV) lanes, and a variety of "non-build" strategies.

The non-build alternatives are often referred to as "travel demand management" or TDM strategies. While adding lanes and interchanges can be viewed as a "supply side" approach to addressing the problems of growth, travel demand management seeks to mitigate the "demand" for highway facilities by influencing travel behavior patterns. This is done by promoting policies that...

> eliminate the trip altogether (i.e., telecommuting, etc.);
>
> reduce the number of vehicle trips by increasing vehicle occupancy (i.e., carpooling, vanpooling, etc.), or;
>
> "spread" peak period demand by promoting "flex time", guaranteed ride home programs, etc. or by congestion pricing.

Two sources of information were used for evaluating these alternatives. The first was the recently updated Indianapolis Regional Transportation Plan (IRTP). The second was a special business/employees' survey conducted as a part of this study to assess the market for these strategies/alternatives.

The IRTP expressly addressed the issues of transit and HOV lanes. The conclusions of the Plan with respect to these concepts are as follows...

PUBLIC TRANSIT

The IRTP examined increased transit service throughout Indianapolis including the possibility of light-rail transit (LRT). Due to financial constraints, the LRT concept was provisionally deemed to be infeasible for all but the I-69/SR 37 corridor between Fishers and downtown Indianapolis. The LRT examination indicated low ridership and very little relief for the highway system. Similarly, expansion of the METRO bus system into Hamilton County did not provide significant relief. While transit does not appear to be a solution to anticipated and future congestion in the corridor, it could conceivably serve as a complement to highway expansion and questions regarding transit were included in the business/employees' survey.

HIGH-OCCUPANCY VEHICLE LANES

The Indianapolis regional transportation planning process also examined the development of high-occupancy vehicle lanes (HOV) on appropriate facilities in the urban area. The "Needs Plan" included HOV lanes on I-69 which continued into downtown Indianapolis on SR 37. Because of a combination of funding and geometric constraints on the SR 37 connection, the HOV lanes were dropped in the "Cost-Feasible Plan".

Similar considerations make HOV unrealistic in the US 31 corridor. R/W constraints in the vicinity of 146th Street present a major obstacle to HOV as do constraints on Meridian Street south of I-465.

BUSINESS/EMPLOYEES' SURVEY

The purpose of the business/employees survey was to provide some empirically derived indication as to the market feasibility of public transit and TDM strategies in the general US 31 corridor. (A question was also asked regarding the desirability of upgrading US 31 to Interstate or freeway were standards. This was not the primary purpose of the survey, but it was felt to be valuable information to obtain as long as a survey was going to be conducted in any case.)

Since most TDM strategies are employer-sponsored or at least require the cooperation of businesses, the sampling frame for the survey was a database of Hamilton County companies with Carmel addresses.

In reality, two surveys were conducted. The first of these targeted chief executive officers or general managers. The second survey sampled employees in several of the same businesses. In all, 14 CEOs/general managers agreed to fill out the survey. Out of this number, 7 agreed to allow distribution of the employees' survey in their company. For companies with less than 500 employees, the survey was distributed to 100% of the employees. Companies with more than 500 workers were asked to randomly sample 500 of their workers. In all, 3,500 surveys were distributed. A total of 554 completed, usable surveys returned. This represents a 15.8% return rate. A copy of the workers' survey instrument and basic statistical tabulations of the employee responses is included in Appendix 4.

In order for a TDM strategy to be successful, it must be accepted both by management and rank-and-file employees. Accordingly, the criterion used for judging a strategy to be potentially feasible was a favorable reading from *both* top management and employees.

CEO/MANAGERS SURVEY RESULTS

With the exception of the question pertaining to the freeway upgrade of US 31, the prevailing sentiment of most of the CEOs/managers was moderately to strongly negative with respect to a majority of the TDM strategies. These results are tabulated in Table 18. The CEOs/managers were generally against such employer-sponsored options as parking subsidies, vanpools, guaranteed ride home programs, preferential parking and monetary transit subsidies. Actions less demanding on the employer, however, were more favorably

TABLE 18
TRANSIT/TDM STRATEGY RATINGS OF SURVEYED CEOs & BUSINESS MANAGERS
US 31 Hamilton County Major Investment Study

Strategy	Strongly Positive	Moderately Positive	Neutral	Moderately Negative	Strongly Negative	Total Responding
Freeway Upgrade	3	3	4	2	2	14
Subsidized Parking	0	1	2	0	10	13
Vanpool Programs	0	2	2	0	9	13
Guaranteed Ride Home	0	2	2	1	8	13
Preferential Parking	0	4	2	1	6	13
Transit Subsidies	0	1	1	2	8	12
Telecommuting	2	3	3	0	4	12
Flexible Work Hours	3	4	0	0	6	11
Rating Totals	8	20	16	6	53	

(although, not overwhelmingly) received. *These positively-rated strategies were telecommuting and flexible work hours.* Preferential parking received slightly less positive ratings.

EMPLOYEES SURVEY RESULTS

Survey research has shown that there is a tendency for respondents to overstate their response to questions relating to prospective participation in a proposed activity. The employees survey was designed to enhance the odds of a realistic response by asking two questions regarding each transit / TDM strategy. The first question asked: "Do you think the strategy is a good proposal for meeting the growing travel demands on US 31 in Hamilton County?" The second question asked: "Will you participate in the program or use the improvement?" By asking both questions, the distinction between a good public strategy idea and personal involvement in the strategy was brought into clear relief. It is felt that this technique resulted in more realistic responses. The respondents were asked to rate each strategy on a general 5-point Likert scale ranging from 1 to 5 where: 1 means "strongly disagree", 2

TABLE 19
TRANSIT/TDM STRATEGY MEAN SCORES OF SURVEYED EMPLOYEES
US 31 Hamilton County Major Investment Study

Strategy	"Good Proposal"	"Personal Participation"
Freeway Upgrade	3.92	3.98
Light Rail	3.15	2.60
Public Transit	3.39	2.40
Transit Subsidies	2.85	2.37
Car / Vanpools	3.23	2.46
Telecommuting	4.01	3.63
Flexible Work Hours	4.33	4.07
Bicycle Planning	3.42	2.83
More Sidewalks	3.49	3.11
Guaranteed Ride Home	3.44	2.75
Preferential Parking	2.92	2.58
Paid Parking	1.54	1.50
Congestion Pricing	1.43	1.46

means "somewhat disagree", 3 means "no opinion", 4 means "somewhat agree", and 5 means "strongly agree". The responses are summarized in Table 19.

As expected, the average "good proposal" scores were almost always higher than the "personal participation" scores. Average "personal participation" scores in excess of 3.0 represent promising strategies. Only 4 strategies fall into this category. They are: (1) freeway upgrade, (2) telecommuting, (3) flexible work hours, and (4) more sidewalks.

The encouraging aspect of these findings is that there is general agreement between management and employees in support of telecommuting and flex time. Since the predominant character of the businesses within the Hamilton County US 31 corridor tends to be white collar professional services, the prospect of telecommuting and flex hours would appear to be very feasible strategies and it is recommended that the State of Indiana consider pursuing policies designed to encourage this kind of working behavior.

CONCLUSION OF THE ALTERNATIVES ANALYSIS

The overwhelming conclusion of the alternatives analysis is that US 31 should be upgraded to freeway standards on its existing alignment between I-465 and 196^{th} Street in Hamilton County. The results of the benefit-cost analysis, transportation performance measures, and public input all corroborate the relative advantages of the "upgrade alternative" over all other reasonable alternatives. The findings of the environmental analysis are not as clear cut, yet there do not appear to be any environmental constraints that would prevent the conversion of the existing highway to a freeway facility.

The preferred alternative should be at least 8 lanes in width from 103^{rd} Street to 161^{s} Street. North of 161^{st} Street, it should be at least 6 lanes. The highway should be designed to urban freeway standards with single-point urban interchanges to conserve right-of-way. An integral aspect of this recommendation is that an additional project be undertaken to enhance the capacity of SR 431 from I-465 to its junction with US 31.

Policies to promote telecommuting and flexible working hours should be investigated for application within the US 31 corridor.

Chapter 4
RECOMMENDED IMPROVEMENT & PHASING PLAN

INTRODUCTION

A discussion of the alternative "build" improvements and "non-build" strategies was provided in Chapter 3. The conclusion of that analysis was that US 31 should be upgraded to urban freeway standards throughout the majority of the Hamilton County study area. It was also concluded that SR 431 should be improved at least to the extent of adding an additional travel lane in each direction. Finally, it was found that two travel demand management strategies - telecommuting and flexible work hours - have real potential in the US 31 / Hamilton County corridor and it was recommended that policies should be undertaken to promote these methods of mitigating peak-hour traffic.

In the current chapter a more refined description of the recommended improvements along US 31 will be provided. This description will include a discussion of some optional treatments near the project's southern terminus at I-465 and near the 146th Street area. More refined project cost estimates and benefit-cost measures based on these options will be discussed. The effects of the "optional" treatments near I-465 will also be provided along with a forecast of the potential effect of telecommuting and staggered work hours.

Following this detailed description of the corridor improvement, a recommended phasing program will be discussed. Eight individual project segments will be defined along with their respective costs. Their independent benefits will then be described and a resulting phasing plan provided.

DESCRIPTION OF THE CORRIDOR IMPROVEMENT

The recommended improvement is an upgrade of US 31 on its existing alignment to urban freeway standards. Figures 25 - 30 provide an overview of the proposed improvement. This new freeway has certain recommended characteristics in terms of lane capacity, access locations, access closures, etc. Each of these aspects of the freeway upgrade are discussed in turn below.

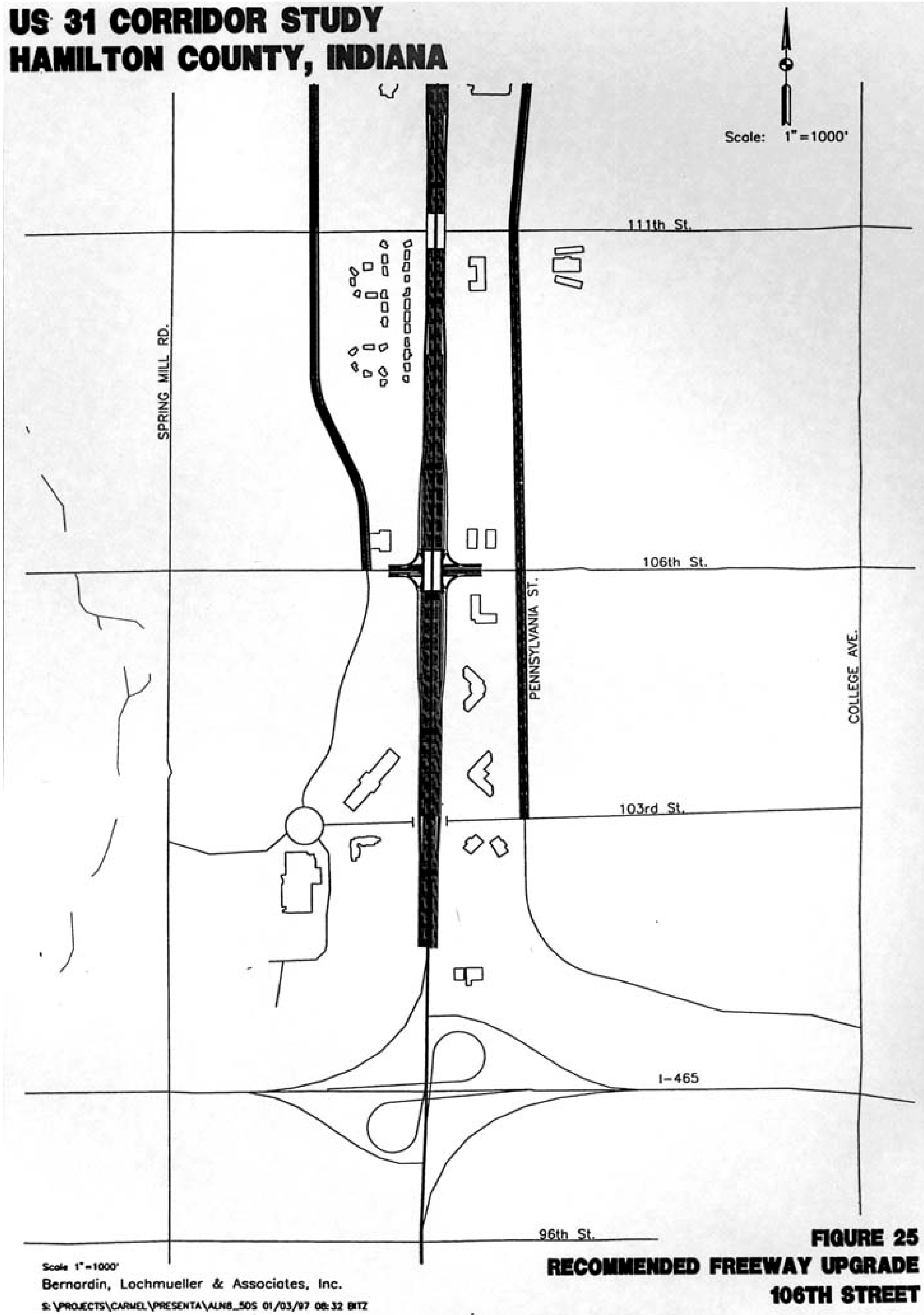


FIGURE 25
RECOMMENDED FREEWAY UPGRADE
106TH STREET

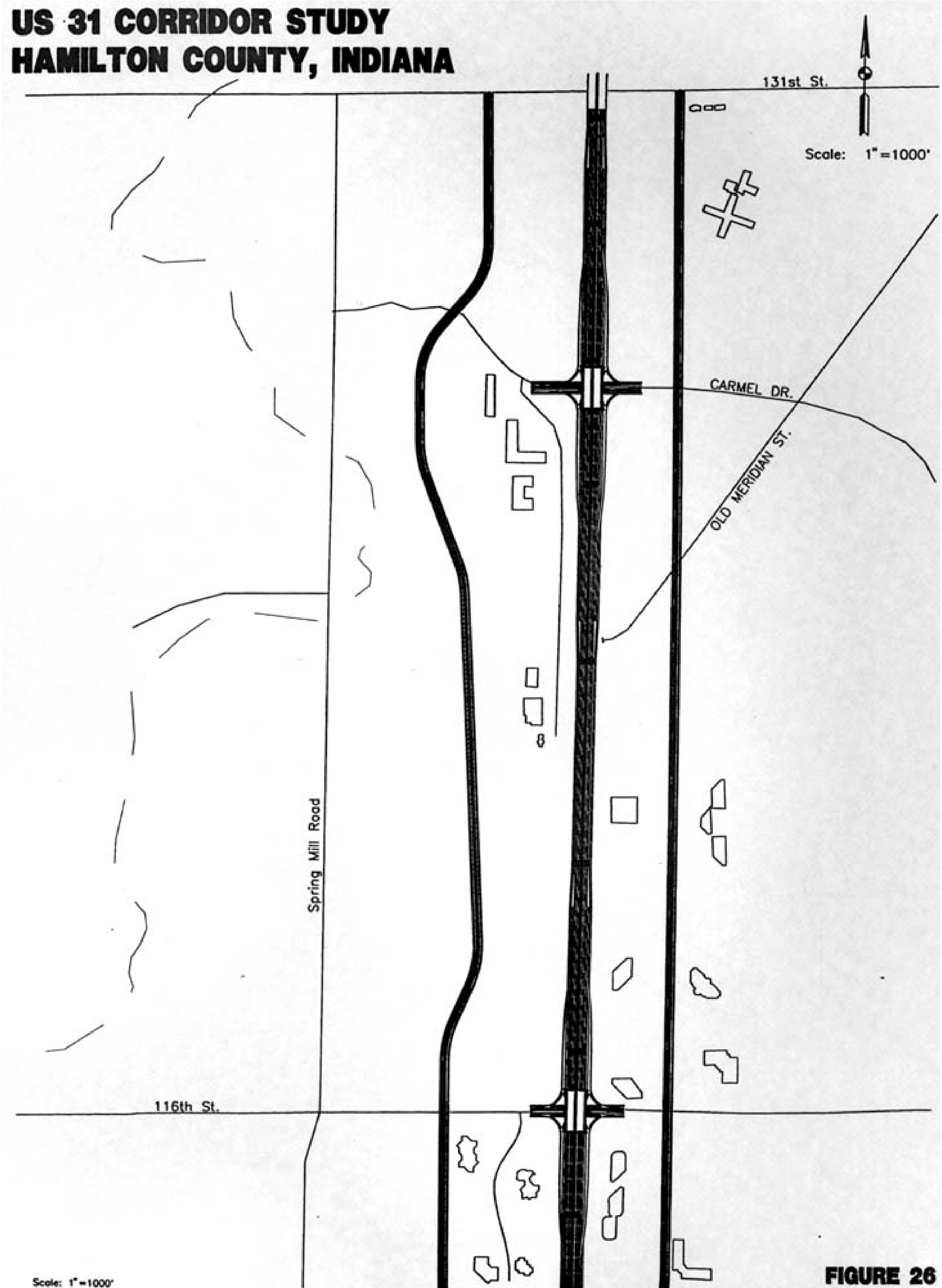


FIGURE 26
RECOMMENDED FREEWAY UPGRADE
116TH - 131ST STREET

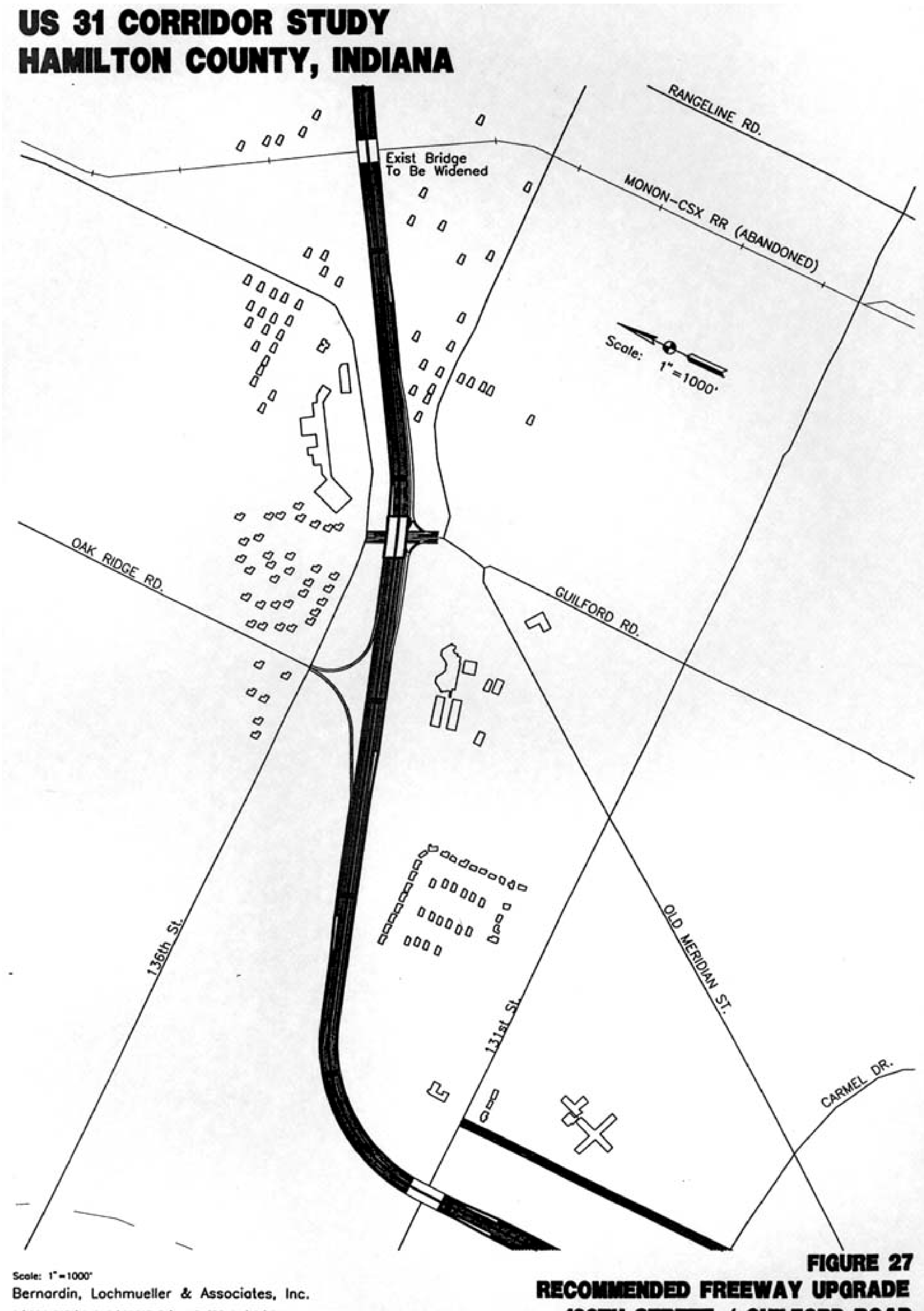


FIGURE 27
RECOMMENDED FREEWAY UPGRADE
136TH STREET / GUILFORD ROAD

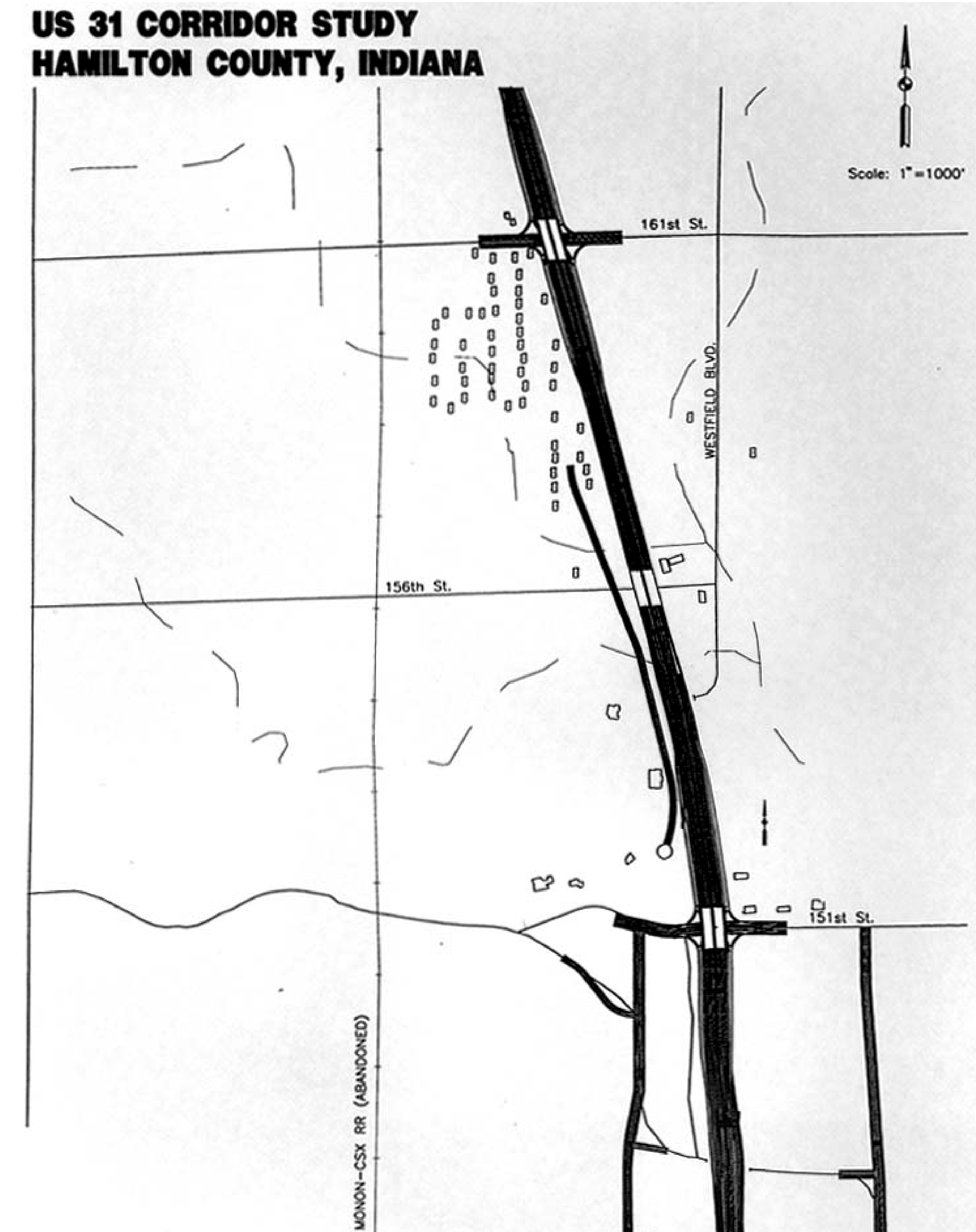


FIGURE 28
RECOMMENDED FREEWAY UPGRADE
146TH - 161ST STREET

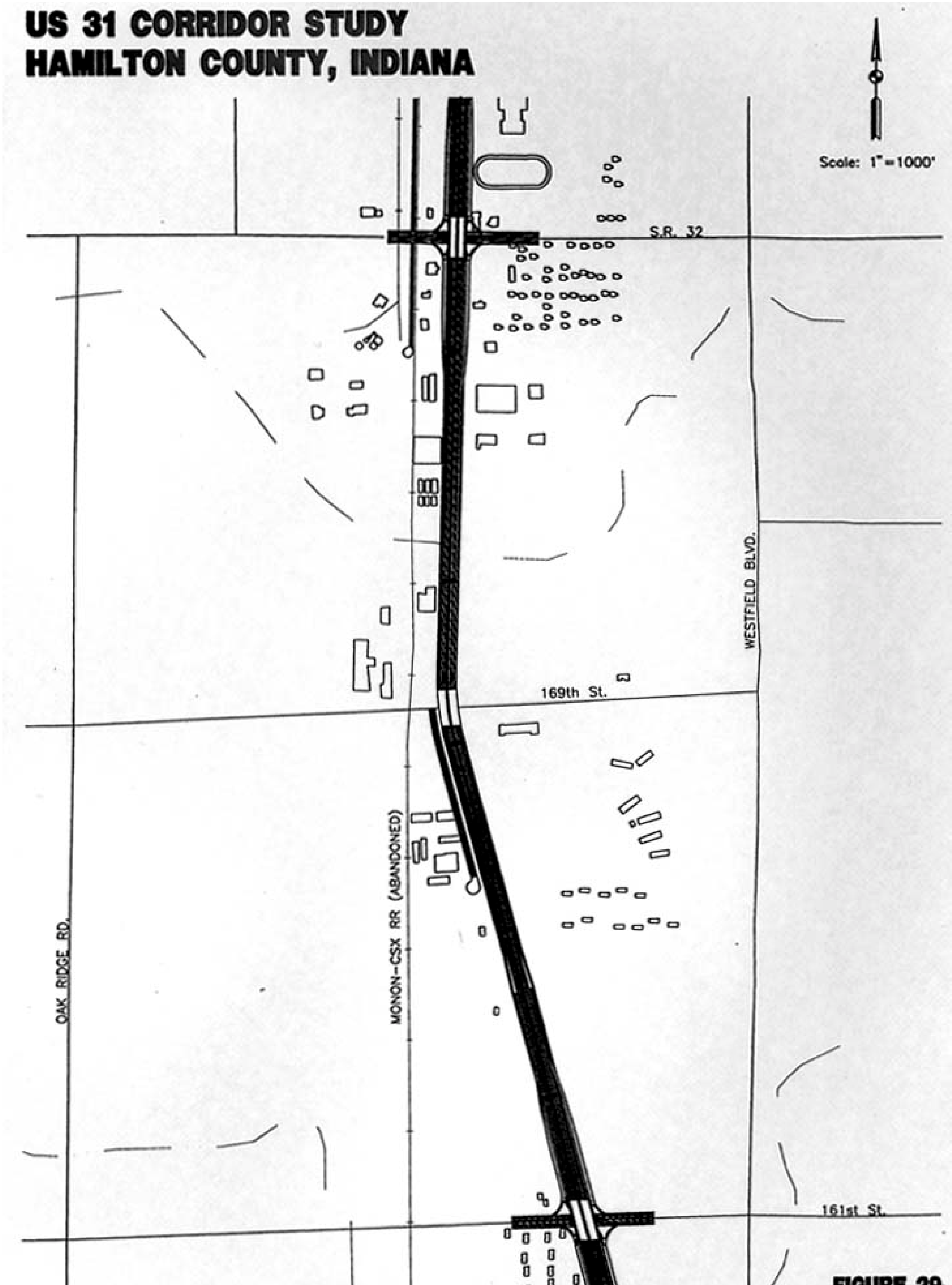


FIGURE 29
RECOMMENDED FREEWAY UPGRADE
161ST - SR-32

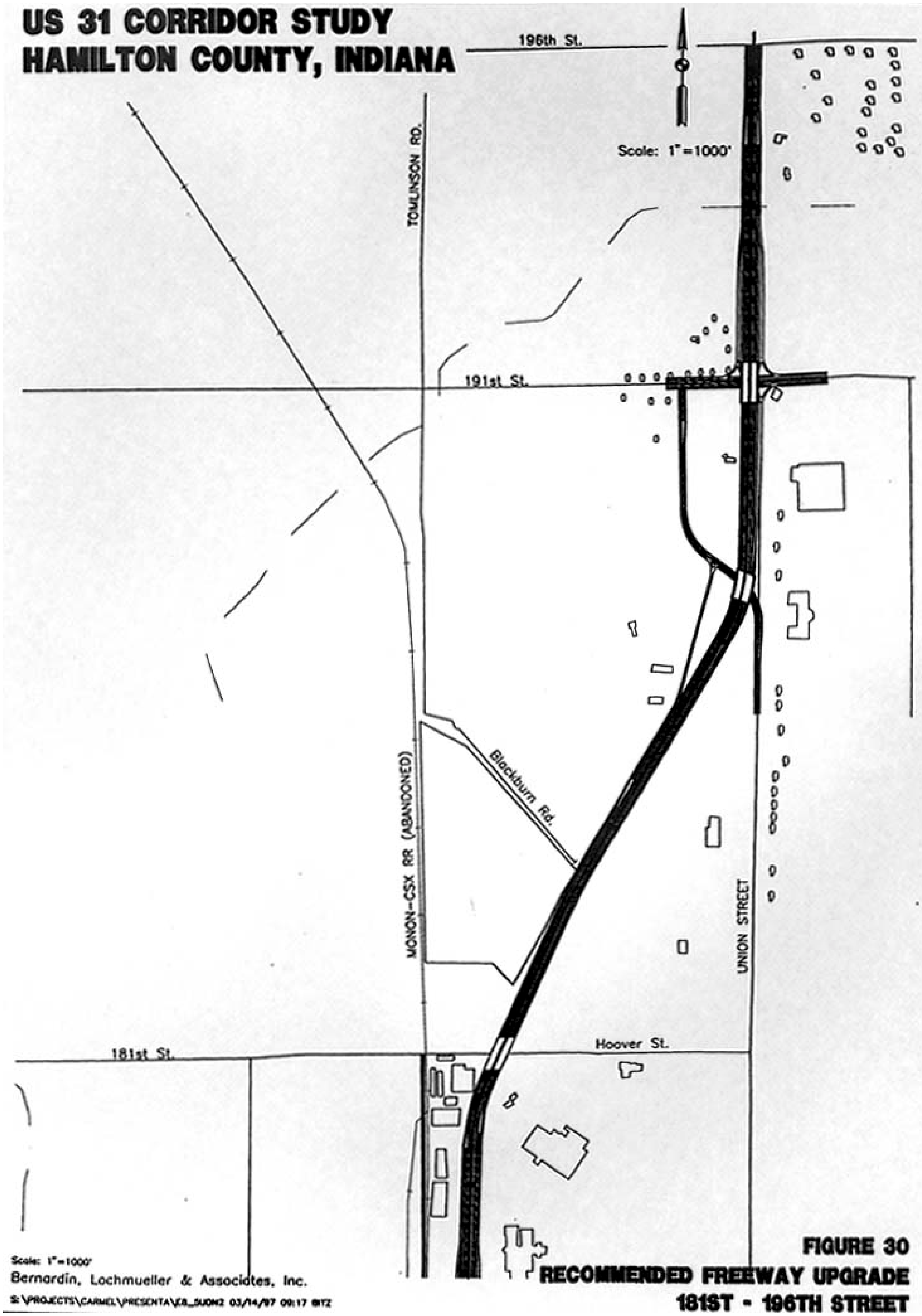


FIGURE 30
RECOMMENDED FREEWAY UPGRADE
181ST - 196TH STREET

LANE CAPACITY

It is recommended that the highway be constructed with 8 travel lanes beginning at 106th Street (4 in each direction) and continuing north up to the northbound 146th Street interchange. For a short distance between exit and entrance ramps, the facility would narrow to 6 lanes (3 in each direction). Passing under 146th Street just north of the merge / diverge point with SR 431, the highway would widen out to either 11 or 12 lanes (including 1 or 2 entrance / exit lanes depending on the exact interchange option that is chosen). Continuing north, at 151st Street the highway would narrow down to 10 lanes (5 in each direction). The fifth north- and southbound lanes would be dropped at the 161st Street interchange as they become off- and on-ramps at 161st Street. Accordingly, at 161st Street the highway would be back down to the 8-lane cross section typical of the segment between 106th and 146th streets. Continuing north, the highway would narrow to 6 travel lanes (3 in each direction) at the off- and on-ramps to SR 32. Between SR 32 and the project's northern terminus at 196th Street, this 6-lane cross section would be used.

The laneage description just given differs from the upgrade alternatives discussed in Chapter 3 in that the recommended plan provides additional capacity between 146th Street and SR 32. The upgrade alternatives assumed 8 lanes between 146th and 151st streets versus 10 lanes (plus 1 or 2 auxiliary lanes) under the recommended improvement. Between 151st and 161st streets, the upgrade alternative assumed 8 lanes, whereas the recommended improvement is 10 lanes. At 161st Street the upgrade alternatives envisioned the highway narrowing to 6 lanes (going north), while the recommended improvement carries 8 lanes all the way up to SR 32 at which point it narrows down to 6 lanes.

The reason for these differences stems from the concern that over the long haul the upgrade alternatives would not provide adequate capacity in the physically constrained 146th Street area. Moreover, at 8 lanes all northbound SR 431 traffic would be forced to merge into US 31 with only one lane. The original configuration of 8 lanes (plus auxiliary lanes) was based on the desire to "fit" the highway within the 146th Street bridge span as originally planned by Hamilton County. When it was learned by the Hamilton County engineers that additional highway capacity would eventually be needed under the bridge, a longer bridge span was approved which allowed for the added lanes. Once the 146th Street "bottleneck" was mitigated, the enhanced capacity was extended north at very little additional cost and dropped incrementally at logical exit ramp locations. (Issues related to additional expense and improved benefit-cost will be discussed later in this chapter.)

ACCESS LOCATIONS

Beginning at the southern end of the corridor, there are several possible improvement options. These options will be discussed in detail later in this chapter. Regardless of which option is chosen, however, access would be provided at each of the following 10 locations...

106th Street
116th Street
126th Street / Carmel Drive
136th Street / Guilford Road
SR 431 (Keystone Avenue)
146th Street
151st Street
161st Street
SR 32
191st Street / Union Street

ACCESS CLOSURES
Existing intersections would be closed at the following 13 locations north of 106th Street. The issue of closing 103rd Street will be discussed below.

111th Street
Old Meridian Street
131st Street
Circle Drive
Rangeline Road
Greyhound Pass
Westfield Boulevard
156th Street
Buena Vista Drive
169th Street
Park Street
181st Street
Blackburn Road

GRADE SEPARATIONS
The access closures listed above do not necessarily imply that the road would be closed. Several of these roads would remain open. In these cases, the roads would be overpassed by the freeway. The list of grade separations include...

111th Street
131st Street
Abandoned CSX Railroad
156th Street
169th Street
181st Street

In the case of 131st Street, the bridge will allow connection of the road across the highway that currently is cut-off by US 31's median.

FIGURE 31

Computer-Enhanced Photo Image of 116th Street Intersection before and after freeway upgrade.

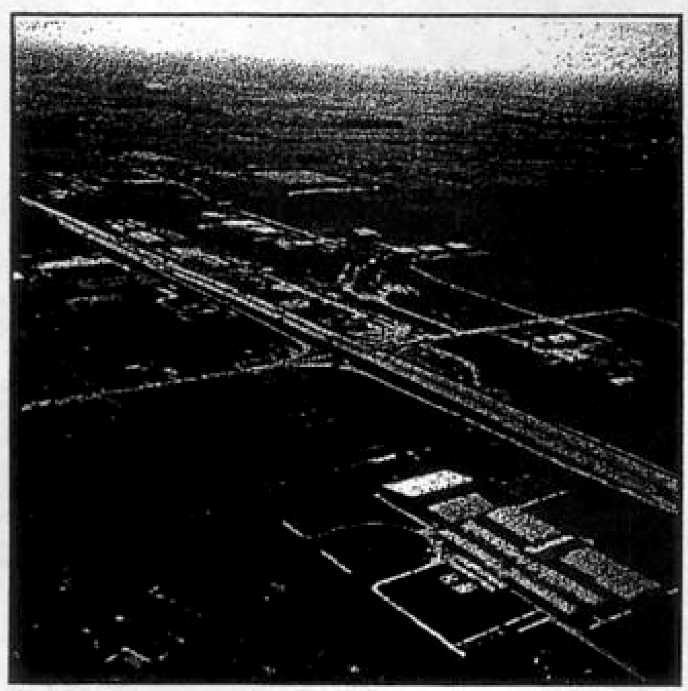
116th Street Existing Intersection

116th Street Computer Enhanced

FIGURE 32

Computer-enhanced Photo Image of SR 32 Intersection before and after freeway upgrade.

SR 32 Existing Intersection



SR 32 Computer Enhanced

FRONTAGE ROADS

The recommended improvement incorporates a frontage road system to allow for the orderly development of US 31 and access to existing properties. These frontage roads are shown in Figures 25 - 28. On the west side of US 31, a frontage road would be extended north from the general vicinity of 106th Street and the northern access drive into Thomson Electronics. This road would terminate at 131st Street. On the east side of the highway, Pennsylvania Road would be developed to provide a continuous connection from 103rd Street to 131st. Both roads would provide for 2-way traffic flow. They would have a 4-lane, undivided cross section with curb and guttering. This frontage road concept can be thought of as "back door" access roads to the abutting, predominantly office developments. Since the roads are essential for future development, it is recommended that at least a "proportional share" of the costs of developing these roads be borne by the land developers.

Service roads will also be required along three other segments of the corridor. The first of these is an integral part of the 146th / 151st Street interchange concept and will be described below. The second involves the realignment of Union Street near 191st Street in Westfield which is also described below. The third road will run parallel to the mainline on its west side extending north and south from 156th Street to provide access to residential properties that currently front on US 31. The road would terminate as a cul-de-sac on both ends rather than extending through to 151st and 161st streets.

TYPICAL INTERCHANGE DESIGN

The type of interchange anticipated for most of the access points along the corridor is a relatively innovative operational concept known as an "urban single-point interchange". While this is not a common interchange design in Indiana, it is frequently used in many urbanized parts of the country. More typical in this state is the conventional diamond interchange which operates with two intersections at the ramp termini on either side of the mainline usually separated by several hundred feet. The difficulty using conventional diamond interchanges along US 31 in the Hamilton County study area has to do with the expansive right-of-way that they require, whereas the single-point design is very efficient in terms of land usage.

A viable alternative to the single-point concept is the "compressed urban diamond" which uses about the same amount of right-of-way and operates with two signalized intersections at the ramp termini abutting the mainline's retaining wall. These compressed diamonds are used in a few places in Indiana. The distinctive feature of the single-point interchange is that it retains the space economy of the compressed urban diamond while "pulling" the ramp termini into a *single intersection* (in this case) underneath the mainline. From the standpoint of operational efficiency, these two interchange concepts are quite competitive; the optimum design depends on the distinctive vehicular movements forecasted at each specific location.

While in many cases, the compressed diamond operates more efficiently than the single-point interchange, it has been shown that the single point concept tends to operate better where left-turn movements predominate over through traffic (on the cross street). This is the prevalent forecasted condition at most of the interchange locations along US 31.

The disadvantage of the single-point interchange concept is that it is more expensive due to the longer bridge span required to fit the intersection underneath the highway. The "single-points" along the Hamilton County segment of US 31 would be designed to allow for dual left turn lanes which translate into an additional expense factor. Notwithstanding this added cost, the benefits derived from smoother traffic flow should be worth the cost. Figures 31 and 32 provide computer-enhanced images of what the single point interchanges would look like at 116th Street and SR 32, respectively.

MODIFICATIONS OF THE TYPICAL INTERCHANGE

Minor variations from the standard single-point interchange will be required in two locations: 136th Street / Guilford Road and 191st Street / Union Street. In the case of 136th Street, land use constraints on the north side of the intersection make it very difficult to fit in all legs of the interchange. Consequently, it is recommended that the southbound off- and on-ramps be moved farther west to intersect with 136th Street at Oak Ridge Road. This concept is depicted in Figure 27. It is, also, recommended that land use controls be exercised so as to protect the real estate between US 31 and 136th Street from encroachment from development.

The second location where a modification from the standard single point design is indicated is at 191st Street. In this case, planning officials from the Town of Westfield requested that access to US 31 be provided to / from Union Street. Access to and from Union Street would provide for greater conformity with Westfield's comprehensive plan. Accordingly, after reviewing several alternatives, the design concept depicted in Figure 30 was chosen in order to accommodate Westfield's objective and avoid an historic structure. The southwest quadrant of the single-point interchange would be pulled west away from the mainline. A 2-way extension of Union Street would cross under the mainline and merge with the southwest quadrant of the interchange at 191st Street. Northbound access to US 31 from Union Street would be at the single-point interchange. Southbound access would be provided on the west side of the mainline

SPECIAL DESIGN ISSUES

Two segments of the corridor present particularly challenging issues. These segments are: the area from Rangeline Road to 151st Street and the area south of 106th Street. The issues will be reviewed and options presented for their resolution.

Rangeline Road to 151st Street The challenges presented by this segment of the corridor have to do with the simultaneous accomplishment of multiple objectives. These objectives include: (1) providing access from 146th Street to both US 31 and SR 431; (2) providing access from Rangeline Road to both US 31 and SR 431; (3) providing the capacity needed to accommodate future development through this already congested segment of the corridor; (4) minimizing disruption to the intensive commercial development between 146th and 151st streets, and; (5) ensuring a safe design for all traffic movements.

The first objective is particularly important to Hamilton County, since its Thoroughfare Plan calls for 146th Street being upgraded to make it the major east-west artery through the county. This represents a major functional change to 146th Street since, at present, it does not even bridge over US 31 and has only indirect access to the highway via Greyhound Pass. Providing access without major disruption to the shopping center in the northeast quadrant of the intersection presents a serious challenge.

A total of 7 different interchange design concepts were investigated. In the end, Configuration "D" was found to be the most satisfactory. The other configurations ("A" through "G") are shown in Appendix 5 along with brief explanations for the reasons they were discarded.

Two slightly different variations of Configuration "D" have been developed. Option "1" is shown in Figure 33 and Option "2" in Figure 34. The basic concept underlying both options of Configuration "D" is the development of "spread" frontage roads between 146th and 151st streets and the elimination of ramps on the north side of 146th Street.

In both options, the frontage road system as well as the ramps south of 146th Street are integral to the achievement of the desired design. Accordingly, advance "protective buying" of the right-of-way for the frontage roads and ramps is strongly recommended to ensure that the interchange configuration can be built in the future.

In both options an 8-lane cross section would be used at the southern end of the project. The fourth northbound lane would be dropped from the mainline as it becomes the 146th Street exit ramp. The fourth southbound lane would be added as the on-ramp from 146th Street merges with the mainline. Northbound US 31 would increase in size to 5 lanes under Option "1" and 6 lanes under Option "2" as the highway passes under 146th Street.

Under both options, southbound US 31 would have a 6-lane cross section as the alignment passes under 146th Street. The 2 inner lanes would be used as access to SR 431. A median barrier wall would separate these 2 lanes from the remaining 4 southbound lanes. This wall would be extended north of the 151st

Street entrance lane in order to eliminate southbound "weaving movements" (i.e., traffic that must change lanes within a short distance) between 151st Street and SR 431.

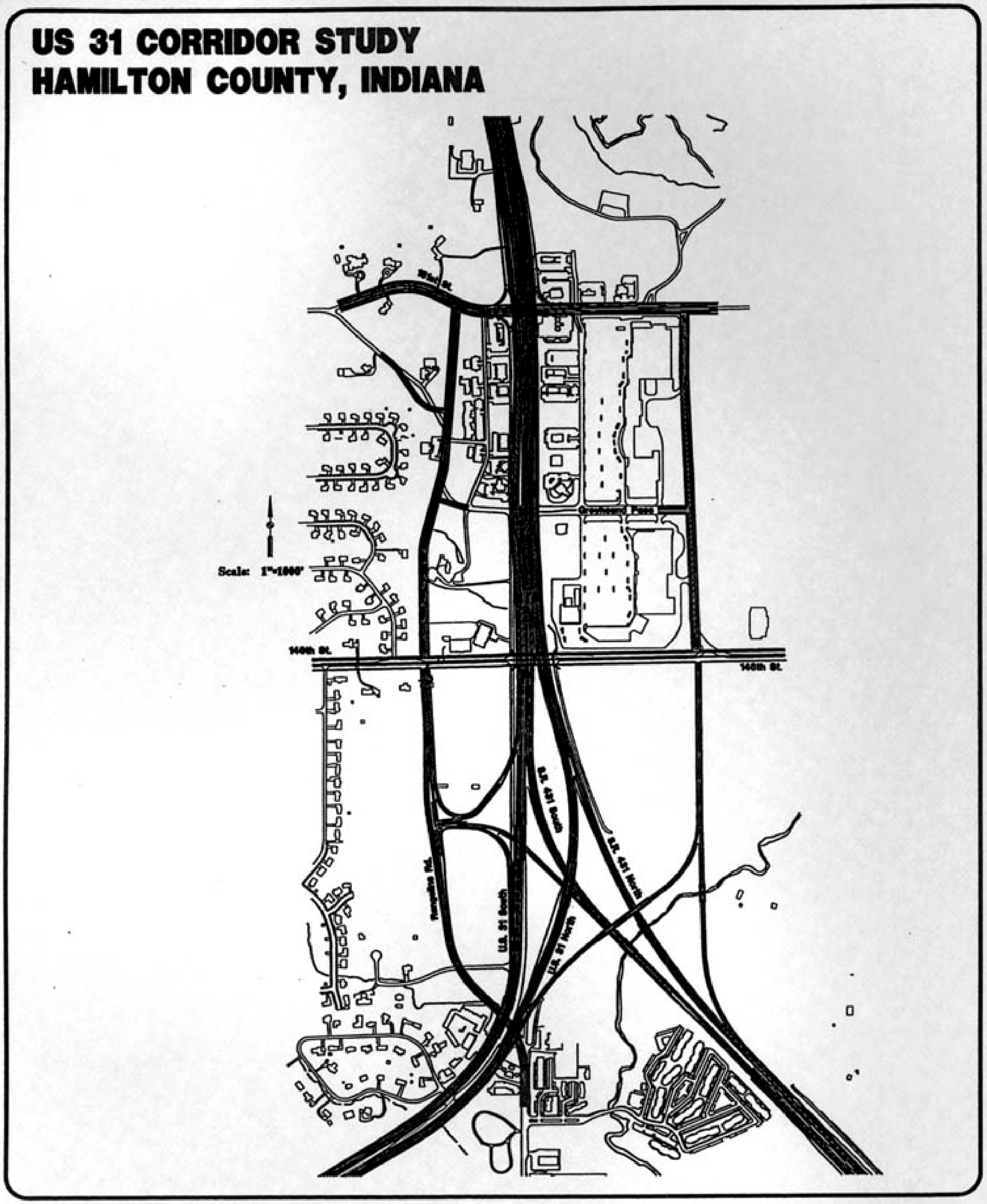
Traffic from 151st Street desiring to go south on SR 431 would use the west side frontage road and proceed south of 146th Street on the extension of Rangeline Road. It would then turn left at the first intersection where an on-ramp to SR 431 would be provided.

The basic difference between Options "1" and "2" is the *extent* of access provided at 146th and 151st streets. In Option "1", the loop on the south side of 146th Street providing northbound access to US 31 would be eliminated. Similarly, the off-ramp for northbound traffic on US 31 to 151st Street (i.e., the southeast quadrant of the interchange) would be eliminated. The elimination of the 146th Street loop was considered because, computer model runs showed that the loop ramp would be underutilized with the majority of northbound traffic going north along Greyhound Pass and entering the freeway at the 151st Street interchange. The elimination of the southeast quadrant of the 151st Street interchange was considered because of an unsafe level of weaving movements for northbound US 31 traffic between the SR 431 merge point and the exit lane to 151st Street. US 31 access to 151st Street would still be provided via the off-ramp at 146th Street and Greyhound Pass. Moreover, with the elimination of this off-ramp, there would be less impact to commercial development on the out lots abutting the mainline.

In Option "2" the rationale for building the 146th Street northbound loop ramp is that it would provide *direct* access from 146th Street. Eventually, this may be needed given the planned importance of this road to the County's overall master plan. The resolution of the weaving movement problem in Option "2" is simply to prevent it from happening. This would be accomplished by extending a median barrier wall separating northbound SR 431 traffic from northbound US 31 traffic to a point north of the 151st Street exit lane. This arrangement would effectively reserve the 151st Street off-ramp for SR 431 traffic. This is not a problem, however, since northbound US 31 traffic desiring to get to 151st Street can still exit at 146th Street and use the new segment of Greyhound Pass that extends north to 151st .

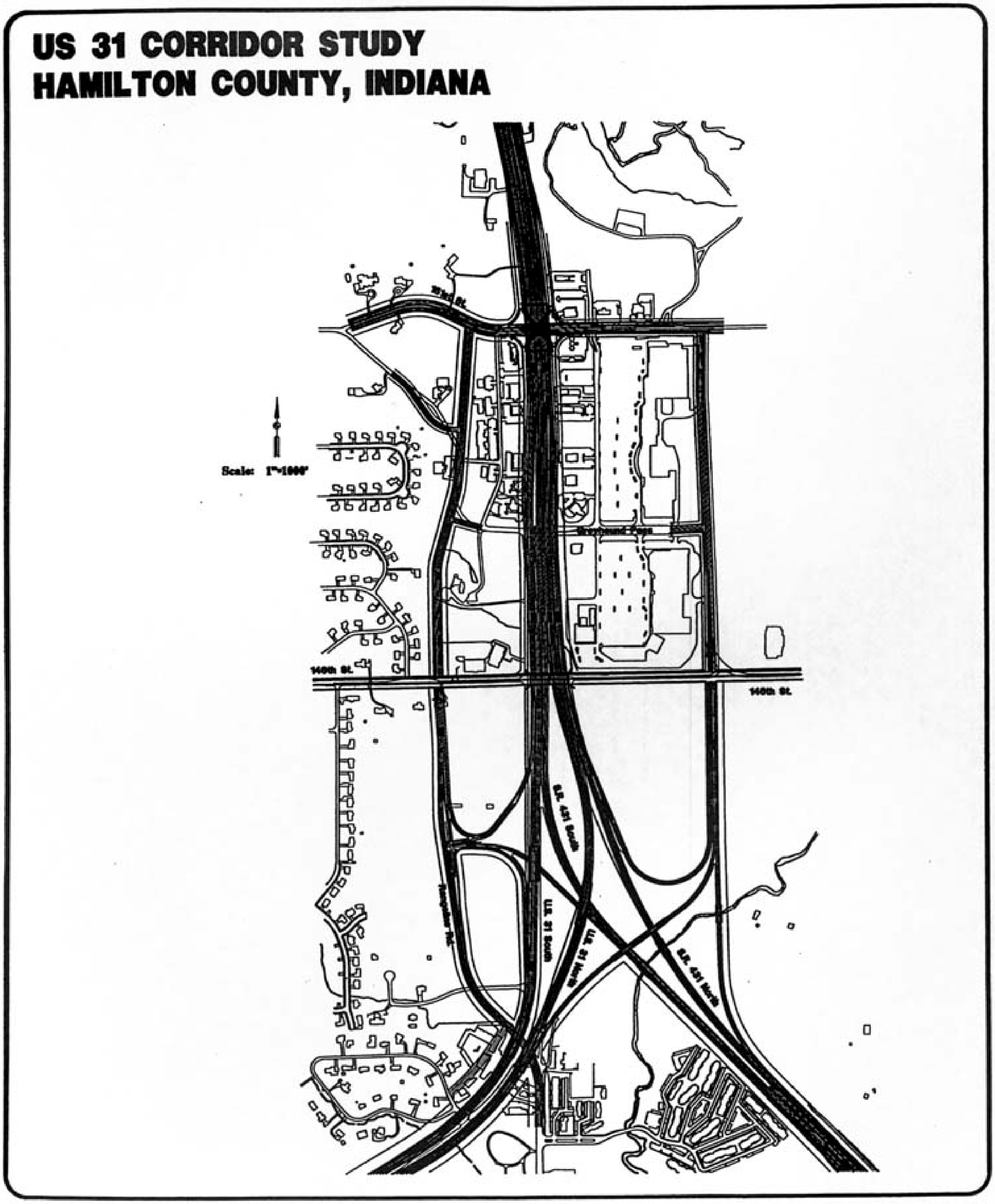
On balance, Option "2" is the preferred alternative since it would provide direct access for northbound traffic on SR 431 to 151st Street and it would relieve some of the demand at the 146th Street off-ramp terminus. The added cost (in 1996 dollars) is estimated at about $8.6 million which is relatively small in the context of the entire corridor improvement.

Interstate 465 to 106th Street Beginning at the southern end of the corridor, an option exists as to whether or not the interchange at I-465 should be upgraded to allow for a freeway-to-freeway connection between US 31 and I-465.



Scale: 1" =1000'
Bernardin, Lochmueller & Associates, Inc.
S:\PROJECTS\CARMEL\PRESENTA\146_202P 03/14/97 11:47 BITZ

FIGURE 33
146th St./ 151st St. INTERCHANGE
Configuration D (Option 1)



Scale: 1"=1000'
Bernardin, Lochmueller & Associates, Inc.

S:\PROJECTS\CARMEL\PRESENTA\146_2D3P 03/14/97 11:34 BITZ

FIGURE 34
146th St./ 151st St. INTERCHANGE
Configuration D (Option 2)

Project Terminus at 103rd Street For the moment, the discussion will focus on the option in which this freeway-to-freeway interchange is *not* constructed. In this case, the project would begin at 103rd Street.

An unresolved design issue relates to whether or not the 103rd Street intersection should remain open. It could either be left open *as is* or closed. Unfortunately, unless the freeway-to-freeway interchange is built, the construction of an interchange at 103rd Street is not an option because of its proximity to the existing westbound ramps at I-465.

For the purposes of traffic forecasting, it has been assumed that fully directional at-grade access to US 31 from 103rd Street would remain as it is. In either case, unless Spring Mill Road was dramatically improved (an unpopular idea), closing 103rd Street would not make a large difference on the mainline forecast of 123,000 ADT just north of I-465. 103rd Street traffic would simply access US 31 three-tenths of a mile farther north at a single-point interchange at 106th Street.

The advantage of leaving 103rd Street open is the ease of access it provides to Thomson Electronics and other important businesses in the area. The disadvantage is the high level of congestion that would occur at this intersection and the abrupt change in the design of US 31 from a freeway to an arterial street. "Driver expectations" of southbound motorists unfamiliar with the highway would be that the facility will remain a freeway all the way to I-465. The presence of a traffic signal prior to arrival at I-465 after many miles of freeway may result in accidents. The recommended course of action is to close 103rd Street late in the highway upgrade process unless the freeway-to-freeway interchange concept (explained below) is developed.

Freeway-to-Freeway Interchange with I-465 The problem of "driver expectations" presents a strong argument for maintaining US 31 as a freeway all the way to Interstate 465. Moreover, as the level-of-service analysis in Chapter 3 indicated, by 2020 the existing intersection at the I-465 westbound ramp terminus will operate at LOS "F" (see Table 15). Alternative interchange improvements at I-465 were considered. Only one configuration resolved the forecasted capacity deficiency without creating new problems. That configuration is the freeway-to-freeway concept presented below and visualized in Figure 35.

The basic concept is to elevate the mainline of US 31 from 106th Street south to its connection with I-465. The elevated mainline would transition to ramps providing for fully-directional movements between US 31 and I-465. The I-465 eastbound-to-northbound movement and the US 31 southbound-to-eastbound movement would be accommodated by high-speed "flyover" ramps bridging over I-465.

US 31 CORRIDOR STUDY
HAMILTON COUNTY, INDIANA

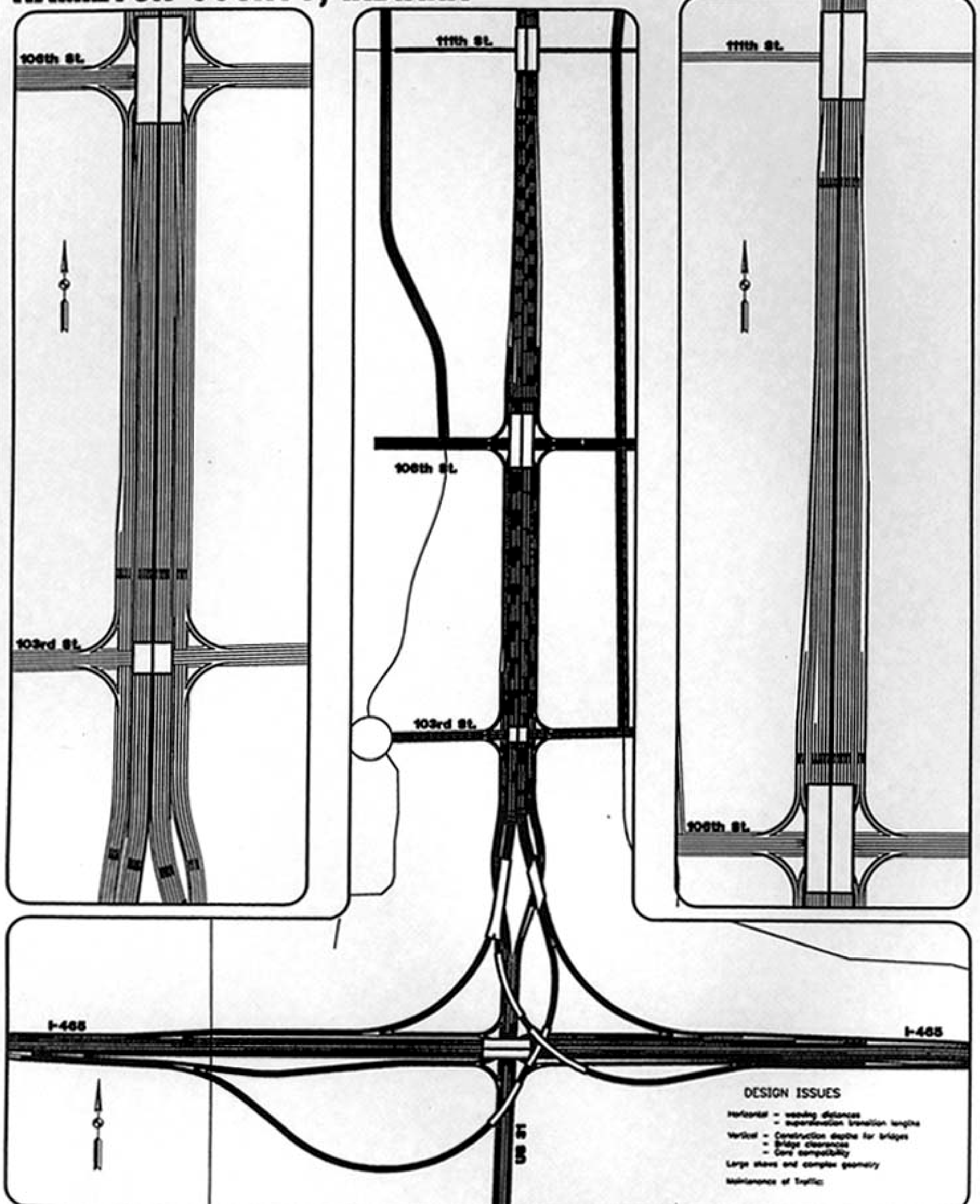
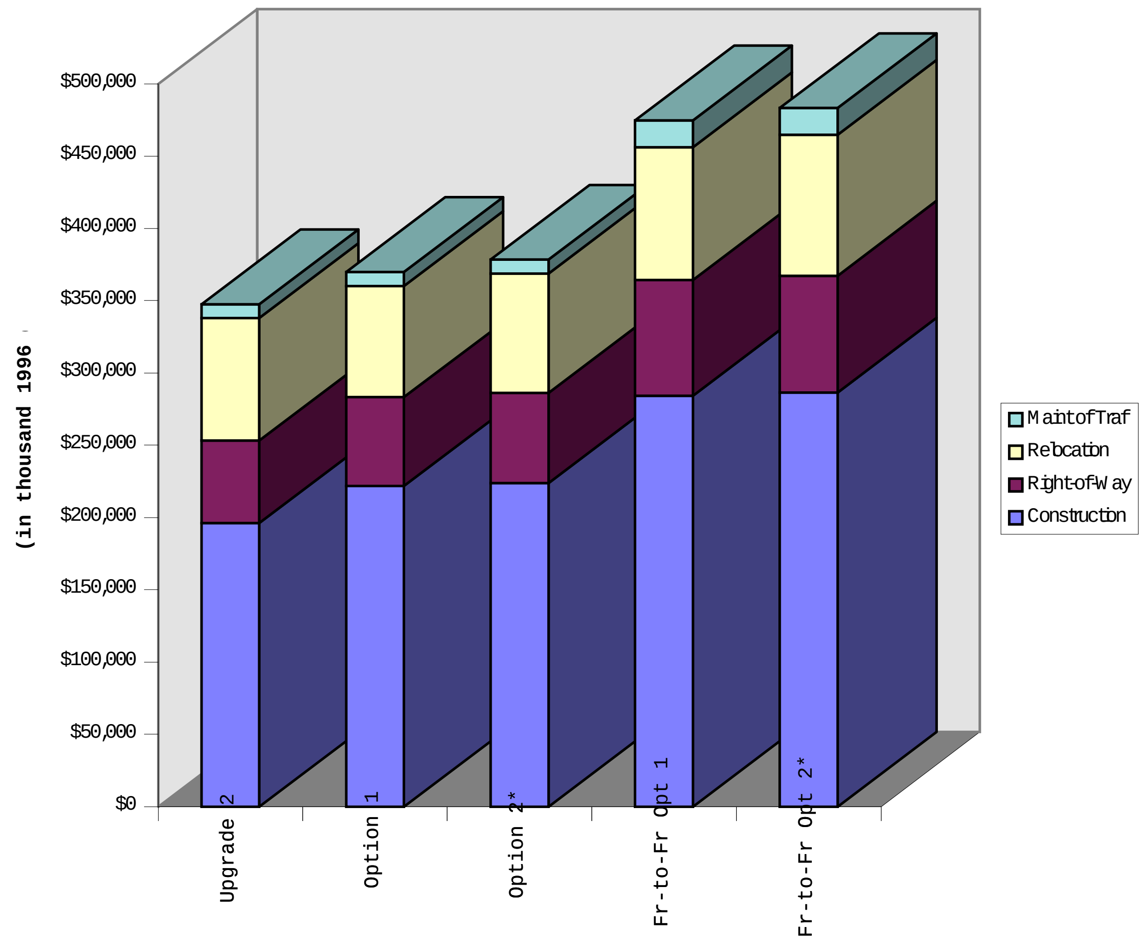


Figure Not To Scale
Bernardin, Lochmueller & Associates, Inc.
S:\PROJECTS\CARMEL\PRESENTA\BOBSINTP 03/14/97 13:43 BITZ

FIGURE 35
US-31 / I-465
FREEWAY-TO-FREEWAY CONCEPT

FIGURE 36 REFINED PROJECT COSTS VERSUS "UPGRADE 2" COSTS



	Upgrade 2	Option 1	Option 2*	Fr-to-Fr Opt1	Fr-to-Fr Opt2*
Construction	$196,135	$221,889	$223,948	$284,257	$286,315
Right-of-Way	$57,084	$61,466	$62,206	$80,196	$80,936
Relocation	$84,821	$76,829	$82,619	$91,806	$97,596
Maint of Traf	$9,560	$9,560	$9,560	$18,300	$18,300
TOTAL	$347,600	$369,744	$378,333	$474,559	$483,147

* Option 2 is recommended. The decision as to whether or not the freeway-to-freeway interchange is incorporated in the corridor improvement should be made at a later date based on available funding.

In this concept 103rd Street would remain open, although it would likely be designed as a compressed urban diamond as opposed to a single-point interchange. This change in concept is due to operational difficulties associated with combining frontage roads with a single-point design. Northbound traffic desiring to exit at 103rd Street would be served by a surface level single-point interchange at I-465, a frontage road extending to 103rd Street (and through it up to 106th Street) and the tight urban diamond at 103rd. Similarly, southbound traffic originating at 103rd Street would make use of the frontage road on the west side of the mainline; this road would also service southbound traffic desiring to proceed south of I-465 on US 31 (Meridian St.).

REFINED PROJECT COSTS

After the alternatives analysis was completed and Upgrade 2 was identified as the preferred alternative (see Chapter 3), more refined costs for Upgrade 2 were estimated and revisions/options were developed. Figure 36 shows the costs for each of the options that were described above. As the figure indicates, the effect of the cost refinements and the addition of travel lanes between 146th and SR 32 resulted in a revision of the cost of Upgrade 2 from $347.6 million to at least $370 million. Configuration "D", Option "1" is estimated at $370 million, while Configuration "D", Option "2" (the recommended alternative) is approximately $378 million. If the freeway-to-freeway interchange is developed between US 31 and I-465, the total project costs increase over $100 million to $470 million and $478 million for Options "1" and "2", respectively.

REFINED BENEFIT-COST ANALYSIS

The cost refinements and more developed project concepts have obvious implications for the benefit-cost analysis. Table 20 summarizes three benefit-cost measures in a manner that allows easy comparison between the original

TABLE 20
COMPARATIVE BENEFIT-COST MEASURES: PRELIMINARY VERSUS REFINED PROJECT CONCEPTS
US 31 Hamilton County Major Investment Study

		Present Value of Total Benefits ($000)	Net Present Value ($000)	Benefit-Cost Ratio
Original Concepts	Alternative 1	$2,299,500	$2,031,061	8.57
	Upgrade 2	$2,511,522	$2,247,746	9.52
Revised Upgr. Concepts	Upgr 2/Option 2	$2,519,262	$2,224,840	8.56
	Fr-to-Fr/Option 2	$2,770,978	$2,394,189	7.35

analysis (as reported in Chapter 3) and the refined concepts as described above. This kind of comparison is important for the purpose of being sure that the more refined costs and project definitions are not such a dramatic departure from the conclusions of the alternatives analysis that other alternatives should be reconsidered.

As Table 20 shows, the present value of total benefits associated with the revised upgrade concepts represent an improvement over both the original Upgrade 2 concept as well as the next best non-upgrade alternative (i.e., Alternative 1). Moreover, the Freeway-to-Freeway / Option 2 concept yields substantially larger benefits than the revised Upgrade 2 / Option 2 alternative.

The net present value (NPV) of both revised concepts are still superior to Alternative 1; however, there is a slight drop for the revised Upgrade 2 / Option 2 versus the original estimate for Upgrade 2. This is, in large part, the result of the refined cost estimates for Upgrade 2. It also has to do with the fact that the potential benefit of the additional laneage north of 146th Street in the revised concept is not going to be fully realized until after the end of the analysis period (i.e., 2029). Sensitivity analysis of the benefit-cost procedure shows that the effect of pushing the opening year five years farther into the future leaving all other assumptions unchanged results in disproportionately much larger growth in the NPV of the revised Upgrade 2 / Option 2 versus that of the original concept. Once again, the Freeway-to-Freeway / Option 2 concept performs better than the Revised Upgrade 2 / Option 2.

The benefit-cost ratios tell a little more complex story. First, the effect of the higher (refined) costs and the added lane capacity does lower the benefit-cost ratio of the refined Upgrade 2 / Option 2 versus the original Upgrade 2. However, it is still on par with the next best non-upgrade (i.e., Alternative 1). The benefit-cost ratio of the revised upgrade with the freeway-to-freeway interchange is significantly lower than the ratio for the same project without the interchange. This shows that the cost of providing the superior benefits associated with this project (expressed both in terms of the present value of the freeway upgrade total benefits and the net present value) is indeed very high.

The "bottom line" of this benefit-cost analysis is that the revised upgrade concept is still clearly superior to any of the non-upgrade alternatives discussed in the previous chapter. The decision, however, as to whether or not the freeway upgrade should include the freeway-to-freeway interchange at I-465 cannot be made on the basis of the benefit-cost analysis alone. If the decision had to be made today under the current constrained funding climate, there simply is not enough money available to "purchase" the benefits that the project would buy. However, as the phasing plan (discussed below) suggests, the decision can and should be delayed for a considerable period of time.

Detailed benefit-cost reports for Upgrade 2/Option 2 with and without the freeway-to-freeway interchange can be found in Appendix 6.

FORECASTED TRAFFIC VOLUMES & LEVELS OF SERVICE

Select traffic volumes for the year 2020 and associated levels-of-service are shown for Upgrade 2/Option 2 on Figure 37. Figure 38 depicts the same data with the freeway-to-freeway interchange added to the project. These data may be compared with Figure 24 which depicts the same information for Upgrade 2 without the freeway-to-freeway interchange and before the additional laneage was added between 146th Street and SR 32.

Figure 37 shows that the net effect of the additional lane capacity would be quite predictable. Forecasted volumes and levels-of-service are shown to be essentially the same south of 146th Street. From that point north, volumes would increase marginally (i.e., 1-5,000 ADT). At the same time, levels-of-service would improve from "D" to "C" between 146th Street and SR 32.

Unlike the nominal change effected by Upgrade 2/Option 2 in the southern part of the study area, Figure 38 shows that the freeway-to-freeway interchange concept would have a large impact on volumes and levels-of-service. Understandably, the interchange with its extensive collector-distributor system and auxiliary lanes would increase average daily traffic just south of 103rd Street from 122,000 ADT to about 144,000 ADT. Of this total, 93,000 would utilize the 8 mainline lanes providing a LOS of "C" for this segment of the traffic. 51,000 ADT would use the collector-distributor system with 6 lanes. Accordingly, the collector-distributor would also operate at a LOS of "C".

The higher volumes would continue all the way north to the merge with SR 431. In the vicinity of 111th Street, US 31 would carry approximately 143,000 ADT on 10 lanes versus 130,000 ADT on 8 lanes. Once again, the additional capacity would more than make up for the increased traffic load. The LOS on this segment would be "D" versus "E" without the freeway-to-freeway concept.

By and large, the effect of the freeway-to-freeway concept would also have a beneficial effect on SR 431, particularly south of 106th Street. Unfortunately, it would not be enough to materially improve the failing levels-of-service on that facility. (Note that SR 431 in both scenarios is assumed to have one additional lane in both directions over what is there today).

TELECOMMUTING AND FLEXIBLE WORK HOURS

One of the recommendations of the last chapter was to promote policies that would encourage telecommuting and staggered work hours along the US 31 corridor. A full description of the US 31 improvements would not be complete without an attempt at quantifying the prospective effects of these two travel demand management strategies.

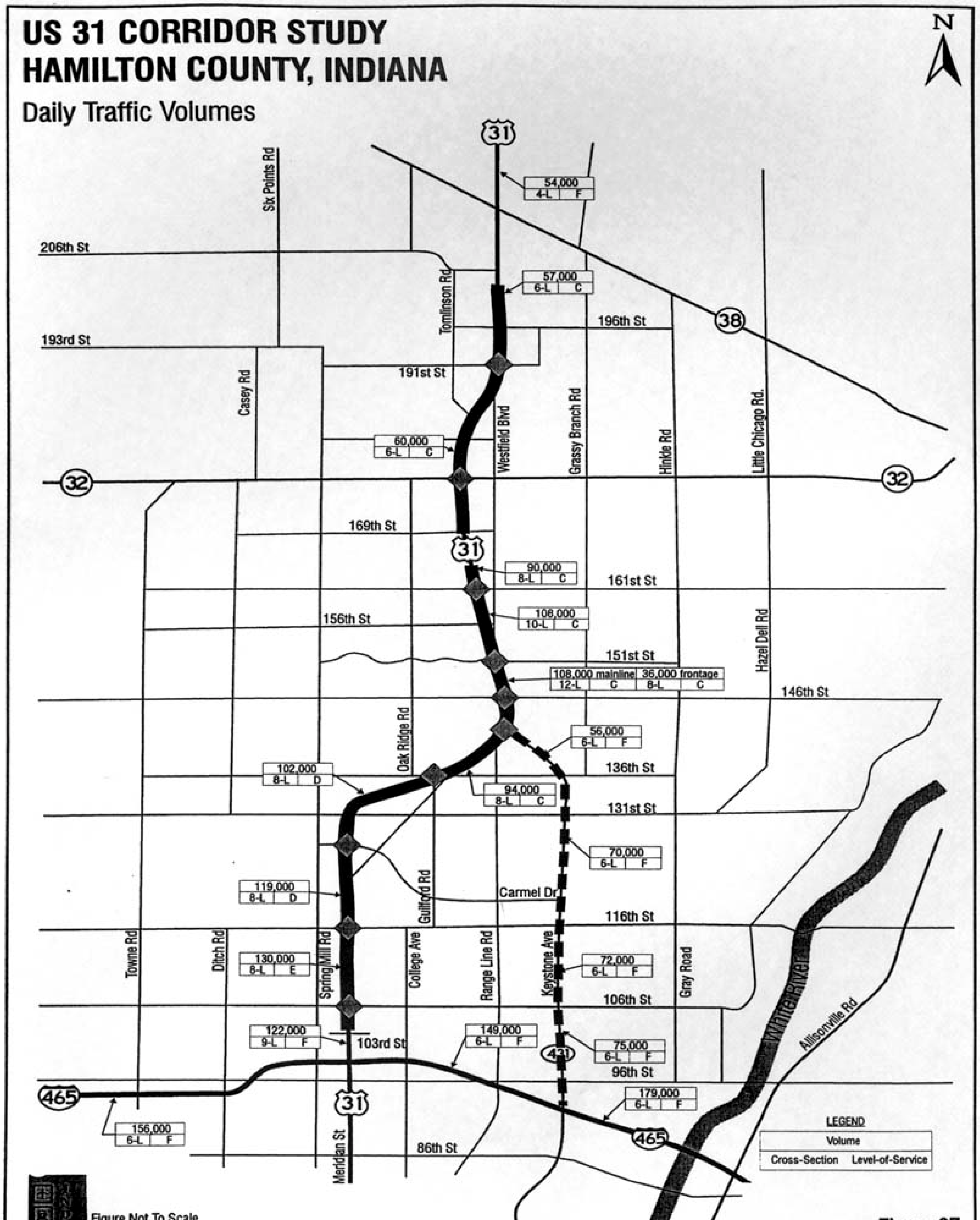


Figure 37
Year 2020 Traffic Volumes & Levels-of-Service
Upgrade 2/Option 2 Alternative

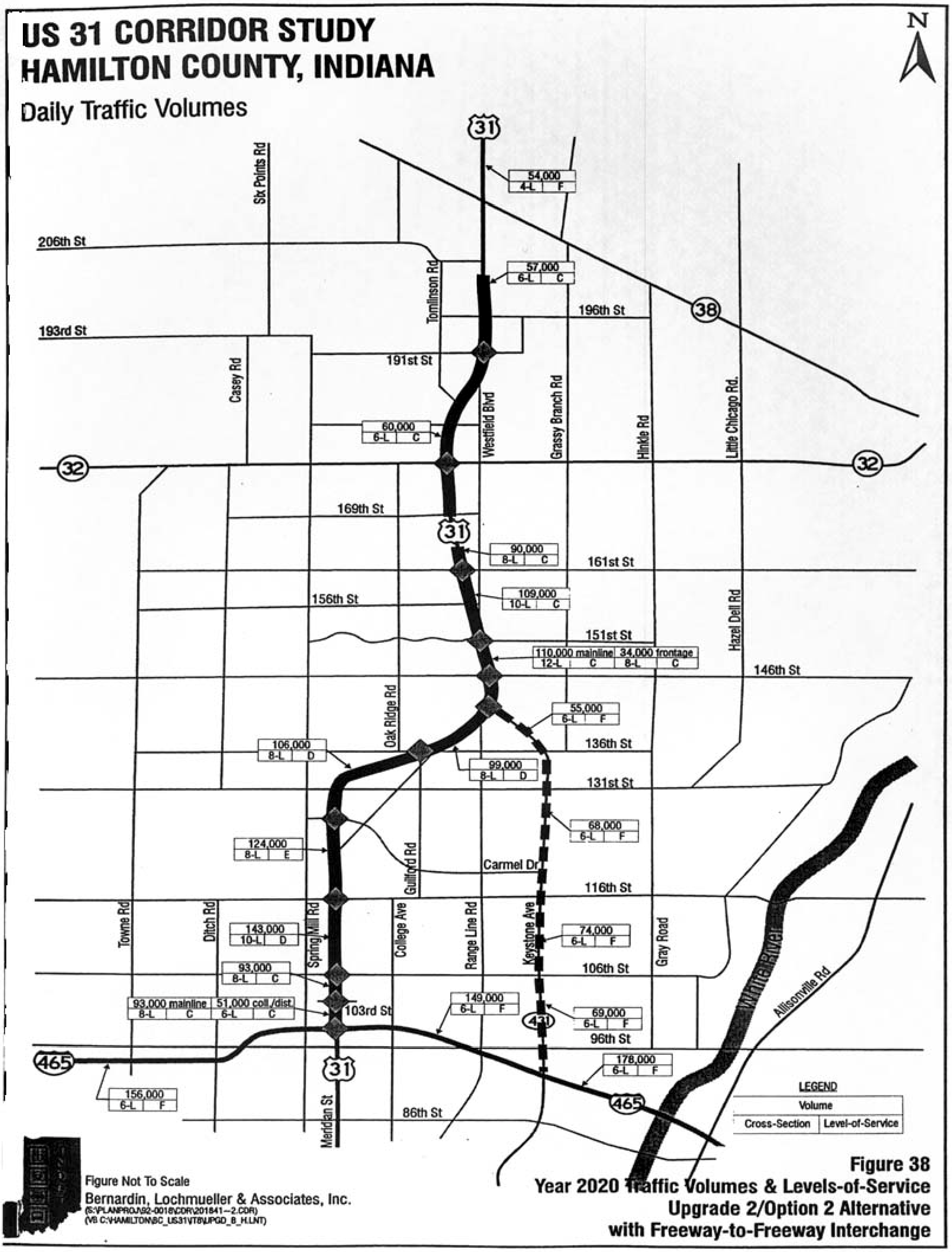


Figure 38
Year 2020 Traffic Volumes & Levels-of-Service
Upgrade 2/Option 2 Alternative
with Freeway-to-Freeway Interchange

A transportation model run was performed to simulate these effects. The model run assumed a 15% reduction in the number of work-related trips with an origin or destination at any of the traffic zones abutting US 31. Work-related trips were defined as home-based work trips as well as a percentage of non-home based and external-internal trips.[21]

Implementing a policy of flexible work hours does not, of course, reduce the total number of trips being made. Instead, it reduces the trips being made during the normal AM and PM peak demand periods. Since the 24-hour traffic volume thresholds used for ascribing levels-of-service (see Table 1) are based on an assumption of 10% of the 24-hour traffic occurring during the peak hour, the phenomenon of "peak spreading" associated with flexible work hours would reduce this peak hour percentage. If peak demand was reduced from 10% to 8%, the 24-hour LOS threshold values would be increased by 25%. This is the assumption that was made.

Figure 39 depicts year 2020 volumes and levels-of-service. The assumed network includes Upgrade 2/Option 2 with*out* the freeway-to-freeway interchange. As the figure suggests, the overall effect of telecommuting on traffic volumes would be very modest. In the aggregate, total vehicle-miles of travel (VMT) throughout the network would drop a negligible 0.7% from 10,421,900 to 10,349,400. Compared with Figure 37, traffic volumes would be reduced along US 31 from 1 - 4,000 ADT south of the SR 431 merge. North of that point the difference is even more negligible. The model seems to suggest that with additional capacity freed up on US 31 as a result of fewer work trips being made within the corridor, traffic from competing parallel streets would simply divert over to US 31. Unfortunately, this diversionary effect would not reach as far east as SR 431.

The good news, however, is that flexible work hours would improve levels-of-service, especially where it is needed the most. Despite the small drop in daily traffic volume between 106th and 116th streets, the LOS (which is based on peak hour conditions) would improve from "E" to "D". A similar improvement from "D" to "C" would take place north of Carmel Drive.

RECOMMENDED PHASING PROGRAM

Having described the recommended corridor improvement, the remainder of this report will focus on the issue of phasing. Clearly, the entire corridor improvement cannot be done at one time. Given the existence of competing transportation needs throughout the state, the corridor plan is too expensive (not to mention too disruptive of traffic flow) to attempt implementation

---

[21] 57% of the non-home based external-internal trips in the corridor were treated as "work-related". This percentage is based on data from the 1992 household travel survey conducted in the South Bend-Elkhart area. (Source: Technical Memorandum VI: Trip Generation Analysis and Model for the Michiana Area Council of Governments, Bernardin, Lochmueller & Associates, Inc., October, 1992.

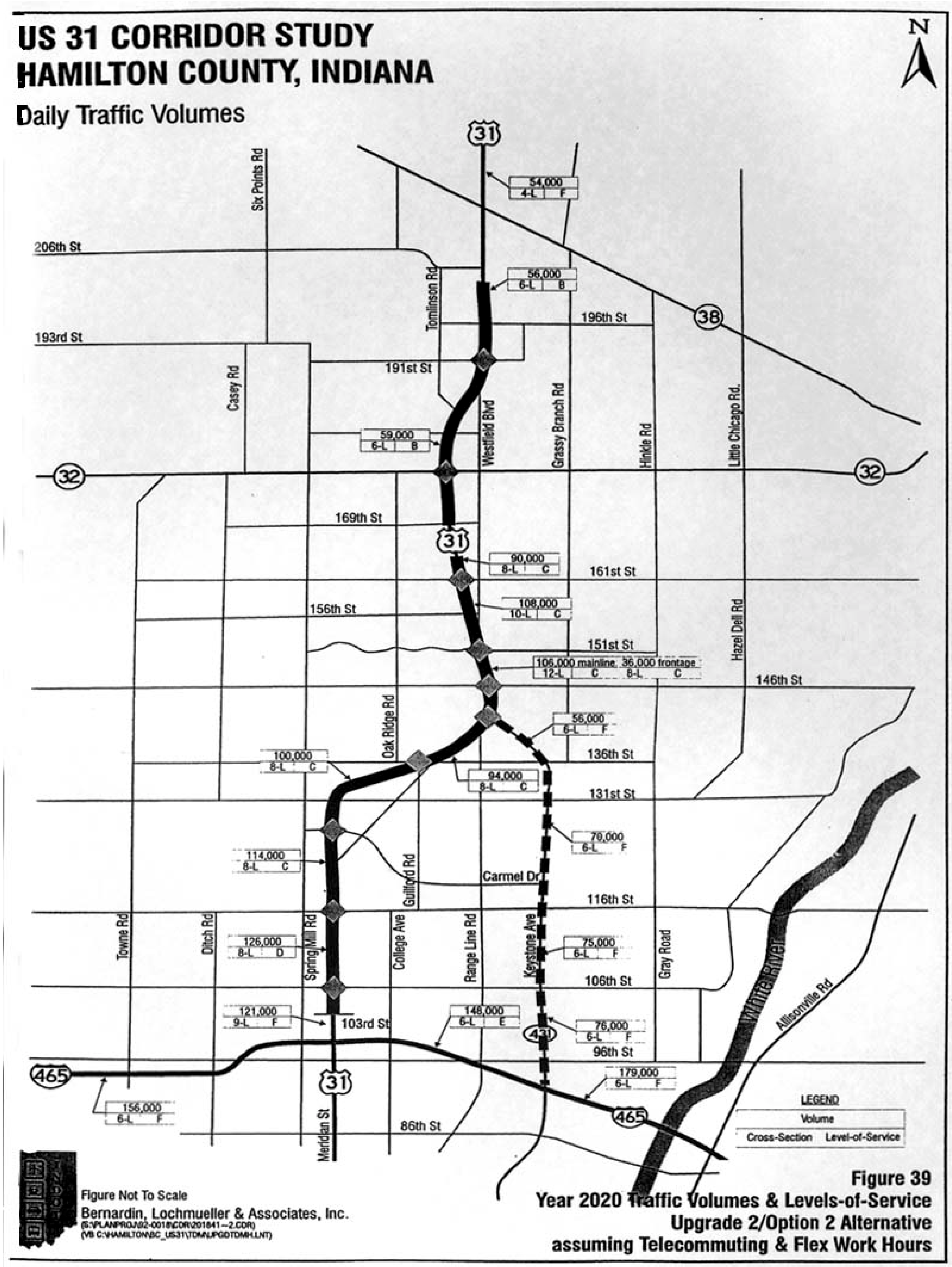
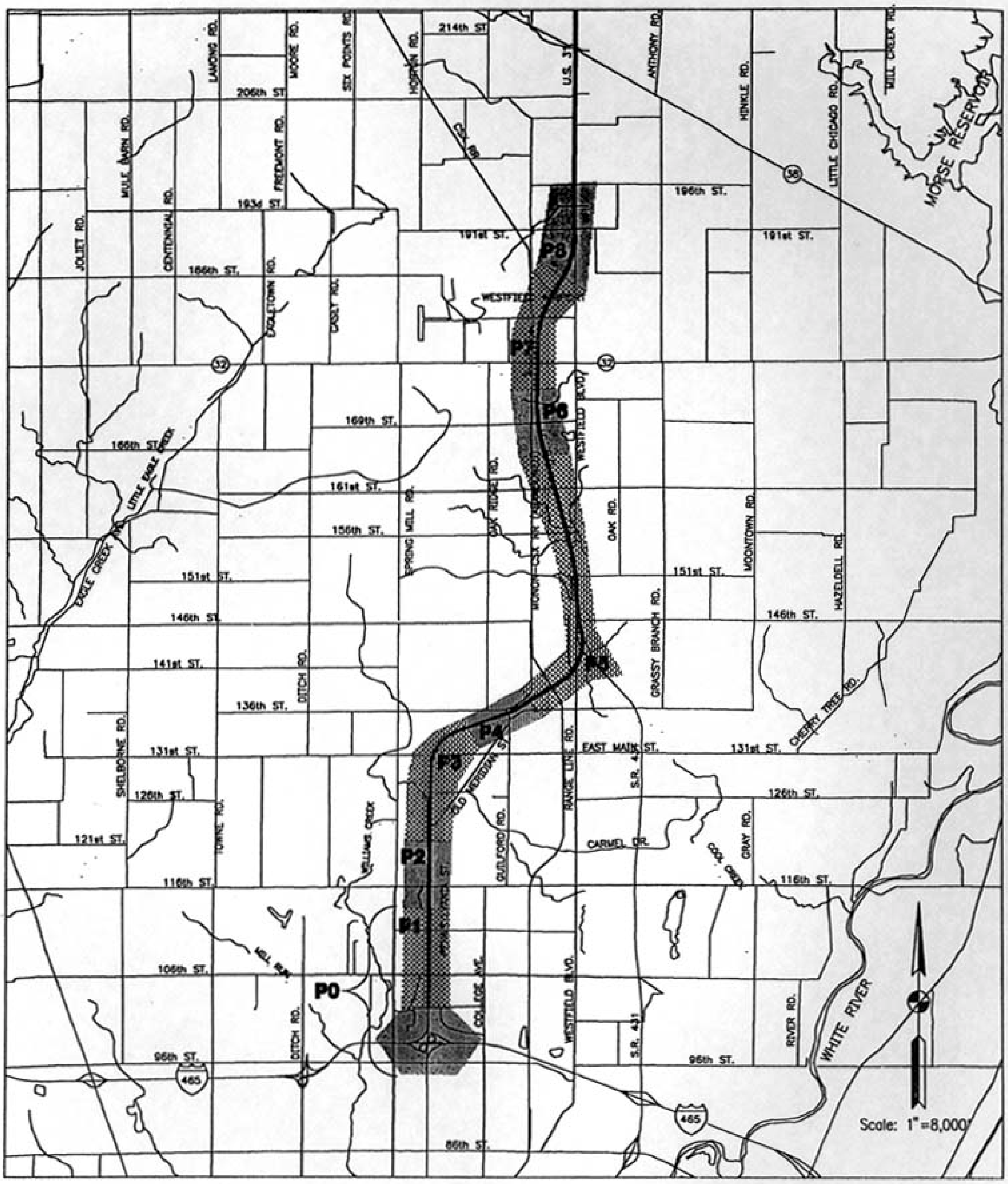


Figure 39
Year 2020 Traffic Volumes & Levels-of-Service
Upgrade 2/Option 2 Alternative
assuming Telecommuting & Flex Work Hours



Bernardin, Lochmueller & Associates, Inc.
\PROJECTS\CARMEL\PRESENTA\FIGURE40 02/18/97 15:18 elc

FIGURE 40
U.S. 31 PROJECT SEGMENTS

within a short time frame. The specific question addressed in the following pages is the proposed *sequence* or order in which segments of the freeway upgrade might be undertaken. No recommendation is made with respect to the time the projects should be built, since that would require a knowledge of all competing state projects. Based on the traffic forecasts, however, it is clear that the need will exist for certain of the projects in the not-too-distant future.

For purposes of construction, the corridor upgrade has been broken into 8 segments referred to hereafter as "projects" or "project segments". The limits of these projects are shown in Figure 40. More exact descriptions of the projects can be found in the *US 31 Hamilton County Major Investment Study Engineering Reports* printed as separate volumes.

In addition to these 8 projects, the frontage roads are effectively treated as a ninth project. The phasing program assumes that the frontage roads will be built before anything else, since they constitute an integral part of the maintenance of traffic plan associated with the mainline construction projects. Similarly, it is assumed that the SR 431 lane additions will be in place.

It should be noted that Project "0" is an optional replacement for Project "1" at the southern end of the corridor. Project "0" is the "freeway-to-freeway interchange" that could be built connecting US 31 and I-465 as an alternative to ending the corridor improvement at 103rd Street. The northern limits of both projects are coterminous, allowing for a clean substitution of one for the other.

Since from a construction standpoint, it is necessary that the projects be self-contained, the termini of each project have been located so as to ensure that they are at-grade. A by-product of this fact is that the projects vary considerably in length and in cost.

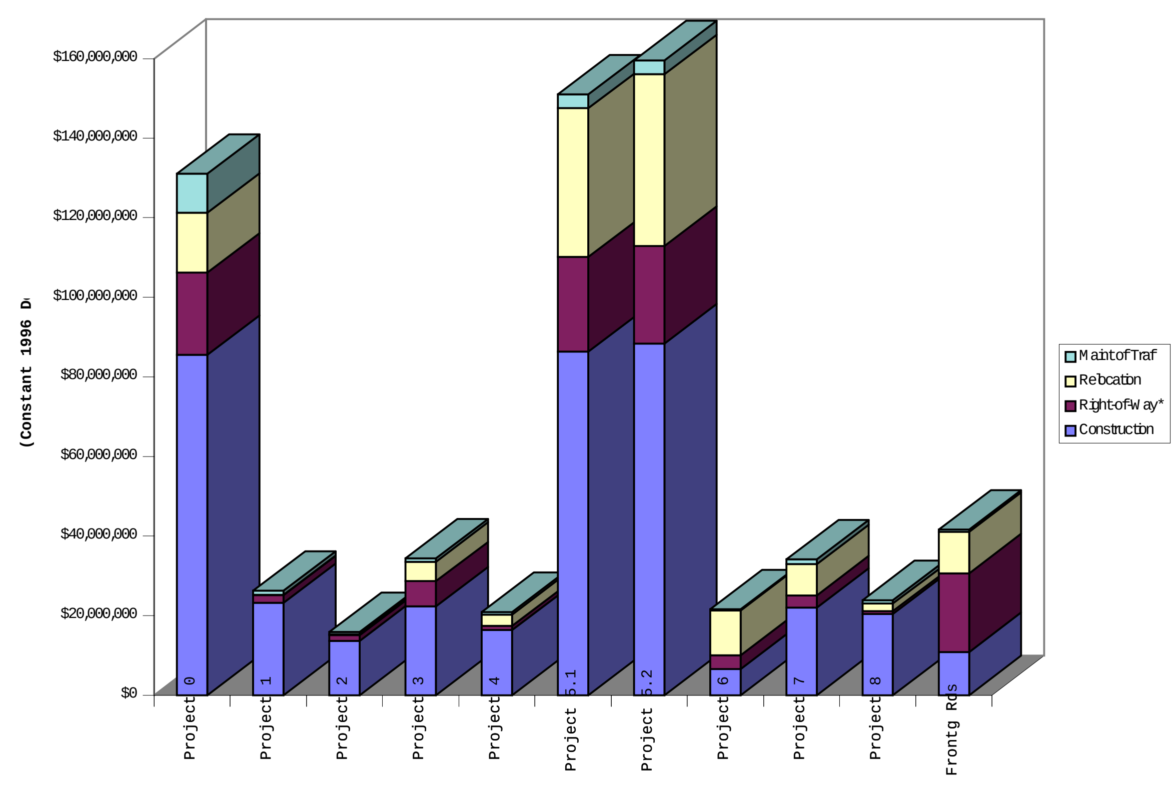
PROJECT SEGMENT COSTS

Figure 41 provides cost detail for the individual project segments. As the figure depicts, Project "5" is significantly more expensive than any of the other segments. Moreover, two optional costs for Project "5" are given, since this segment includes the 146th/151st Street interchange. Projects "5.1" and "5.2" refer to interchange options "1" and "2" shown earlier in Figures 33 and 34, respectively. Figure 41 also points out the magnitude of the additional investment that would be required for Project "0"; about $105 million more than Project "1".

PROJECT SEGMENT BENEFIT-COST RESULTS

In order to aid in the development of a logical phasing program, benefit-cost analysis was conducted for each of the 8 project segments plus Project "0". This analysis involved separate runs of the transportation computer model for each individual segment in order to isolate their unique user benefits.

FIGURE 41 PROJECT SEGMENT COSTS



	Project 0	Project 1	Project 2	Project 3	Project 4	Project 5.1	Project 5.2	Project 6	Project 7	Project 8	Frontg Rds
Construction	$85,544,809	$23,187,898	$13,669,855	$22,340,401	$16,379,250	$86,358,522	$88,417,000	$6,623,003	$22,009,698	$20,442,080	$10,878,656
Right-of-Way*	$20,687,000	$1,956,650	$1,424,200	$6,292,000	$1,044,400	$23,778,000	$24,518,000	$3,443,200	$3,083,000	$671,600	$19,773,000
Relocation	$15,040,000	$63,000	$215,000	$4,900,000	$2,869,500	$37,365,000	$43,155,000	$11,255,000	$7,842,500	$1,885,000	$10,434,000
Maint of Traf	$9,810,000	$1,060,000	$570,000	$870,000	$620,000	$3,500,000	$3,500,000	$290,000	$1,250,000	$880,000	$520,000
Sub-Totals	$131,081,809	$26,267,548	$15,879,055	$34,402,401	$20,913,150	$151,001,522	$159,590,000	$21,611,203	$34,185,198	$23,878,680	$41,605,656

Total Option 1 Without Freeway-to-Freeway Interchange $369,744,413 **Total Option 1 With Freeway-to-Freeway Interchange $474,558,674**
Total Option 2 Without Freeway-to-Freeway Interchange $378,332,891 **Total Option 2 With Freeway-to-Freeway Interchange $483,147,152**

* "Project 0" represents the frontage roads. "Project 5.1" is signifies Option 1. "Project 5.2" signifies Option 2 which is recommended.
R/W costs estimated with real estate fully developed. Significant savings should be possible with advance protective buying.
Approximately $11 million for adding a travel lane in the SR 431 median is not included in these totals. It is assumed that at least
this much of the total upgrade cost can be saved by protective buying

Table 21 summarizes the benefit-cost results for the individual project segments. Benefit-cost ratios, net present values, and total discounted benefits are reported. The first thing that "jumps out" of the table is the wide range of benefit-cost ratios. Values range from 0.7 for Project "6" to 21.3 for Project "4".

One should not, however, be too quick to throw out Project "7" simply because its benefit-cost ratio is less that 1.0. The individual projects working together as a completed corridor improvement create a synergy that it greater than the sum of the individual parts. Specifically, the sum of the net present values of Projects "1" through "8" is about $1.75 billion versus the net present value for the total corridor improvement of $2.22 billion. Project "7" is an integral part of the whole and helps to create the synergy. The reason for Project "7"'s apparently poor performance is simply a function of the way it is defined. It is a very short project that closes 169th Street and does not replace it with an interchange. Consequently, if this project was built by itself, its user benefits would be negligible which is what the analysis suggests.

TABLE 21
COMPARATIVE BENEFIT-COST MEASURES FOR INDIVIDUAL PROJECT SEGMENTS
US 31 Hamilton County Major Investment Study

	Present Value of Total Benefits ($000)	Net Present Value ($000)	Benefit-Cost Ratio
Project "0"	$339,182	$237,749	3.34
Project "1"	$260,796	$240,327	12.74
Project "2"	$203,214	$190,906	16.51
Project "3"	$328,219	$301,676	12.37
Project "4"	$349,039	$332,624	21.26
Project "5"*	$664,673	$548,275	5.71
Project "6"	$12,338	($4,711)	0.72
Project "7"	$105,235	$78,327	3.91
Project "8"	$63,901	$45,211	3.42

* These results are for Interchange Option 2.

A second fact that Table 21 brings out is the low correlation between the benefit-cost ratios and the net present values. This is a function of the widely disparate costs of the project. If they were more comparable in cost, the correlation would be much stronger.

Table 22 provides an ordinal ranking of projects from best performer (i.e., 1st place) to poorest performer (i.e., 9th place) for each of the three benefit-cost measures. The rankings are different because each of the values tell us something different. For purposes of interpretation, the rankings based on benefit-cost ratios are of greatest value in an era of extreme fiscal constraint, since they reflect the *rate* of return for a fixed investment. These rankings give no weight to the magnitude of the user benefits themselves, but rather the ratio of the benefits to the costs. Accordingly, a project can have a high benefit-cost ratio without really delivering large benefits if the project itself does not cost much.

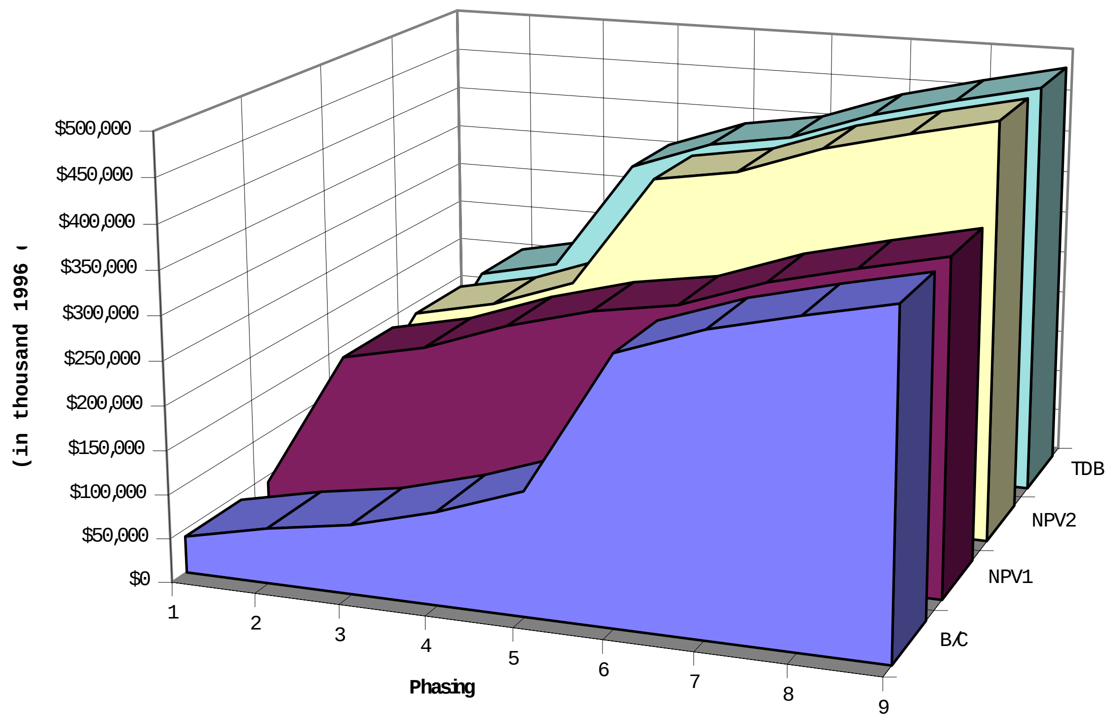
The rankings based on net present values, on the other hand, are based on the amount of the benefits left over after all costs have been deducted out. Accordingly, they should be more important to INDOT if the state is willing to spend more to get more.

At the opposite end of the continuum from benefit-cost ratios in terms of fiscal conservatism are the rankings based on the present value of total benefits (i.e., total discounted benefits). Strictly speaking, the present value of total benefits is not a cost effectiveness measurement at all, since it does not take cost into consideration. If money was "no object" and literally the only consideration was the benefits to be derived from competing projects, decisions would be made on the basis of the present value of total benefits.

TABLE 22
RANKING OF PROJECT SEGMENTS ON THE BASIS OF ALTERNATIVE BENEFIT-COST MEASURES
US 31 Hamilton County Major Investment Study

	Rankings Based on Total Benefits	Rankings Based on Net Present Value	Rankings Based on Benefit-Cost Ratio
1st Place	5	5	4
2nd Place	4	4	2
3rd Place	0	3	1
4th Place	3	1	3
5th Place	1	0	5
6th Place	2	2	7
7th Place	7	7	8
8th Place	8	8	0
9th Place	6	6	6

FIGURE 42 PHASING & COST ACCUMULATION BASED ON ALTERNATIVE BENEFIT-COST MEASURES



PROJECT PHASING & COSTS BASED ON BENEFIT-COST RATIOS (B/C):

Project	Frontg Rds	Project4	Project2	Project1	Project3	Project5	Project7	Project8	Project6
Cost	$41,606	$20,913	$15,879	$26,268	$34,402	$159,590	$34,185	$23,879	$21,611

PROJECT PHASING & COSTS BASED ON NET PRESENT VALUES WITHOUT FR-TO-FR INTERCHANGE (NPV1):

Project	Frontg Rds	Project5	Project4	Project3	Project1	Project2	Project7	Project8	Project6
Cost	$41,606	$159,590	$20,913	$34,402	$26,268	$15,879	$34,185	$23,879	$21,611

PROJECT PHASING & COSTS BASED ON NET PRESENT VALUES WITH FR-TO-FR INTERCHANGE (NPV2):

Project	Frontg Rds	Project5	Project4	Project3	Project0	Project2	Project7	Project8	Project6
Cost	$41,606	$159,590	$20,913	$34,402	$131,082	$15,879	$34,185	$23,879	$21,611

PROJECT PHASING & COSTS BASED ON TOTAL DISCOUNTED BENEFITS (TDB):

Project	Frontg Rds	Project5	Project4	Project0	Project3	Project2	Project7	Project8	Project6
Cost	$41,606	$159,590	$20,913	$131,082	$34,402	$15,879	$34,185	$23,879	$21,611

A review of Table 22 reveals a tendency for the expensive projects to rise from poor or mediocre to relatively good moving across the continuum from rankings based on the benefit-cost ratio to rankings based on benefits alone. For example, the freeway-to-freeway interchange (i.e., Project "0") is next to last under benefit-cost ratio rankings. It moves up to 5th place under the net present value rankings and 3rd place in the total benefits ranking. Similarly, Project "5" is in 5th place in the benefit-cost ratio rankings and moves to 1st place in both the net present values and discounted total benefits rankings.

The choice of which measurement to base the project phasing program on (if any) has major implications for the timing of expenditures. Figure 42 depicts the phasing and cumulative costs (in constant 1996 dollars) based on the three rankings in Table 22. As the figure shows, phasing the projects based on benefit-cost ratios is the least demanding in terms of cost in the early years of the program. Moreover, since the ranking for Project "1" is dramatically better than Project "0", there would be little justification for building the freeway-to-freeway interchange if the program is based on relative benefit-cost ratios. Accordingly, the total cost of the corridor improvement would be around $380 million versus over $480 million with the freeway-to-freeway connection.

Under a phasing program based on net present values, the ranking of Projects "0" and "1" are so close that cumulative costs are shown for both scenarios in Figure 42. In either case, there would be more expense incurred "up front" than would be incurred under the benefit-cost rankings. On the other hand, the *inflated* costs of the total corridor improvement would be less (assuming Project "1") precisely because the expensive elements would not be delayed into the distant future.

As Figure 42 indicates, the accumulated costs related to a phasing plan based on benefits alone would be the most demanding of the three in the early years. Moreover, the competition between Projects "0" and "1" would clearly favor the more expensive freeway-to-freeway interchange.

PROPOSED PHASING

The recommendation of this study with respect to phasing the project segments is loosely based on the net present value rankings, a mid-course between benefit-cost ratios and total benefits. The 8-phased program is listed in Table 23.

While there is little doubt that we are currently living in an era of tight capital financing constraints -- a fact that would tend to favor a phasing plan based on benefit-cost ratios -- the net present value rankings allow for the possibility that there may be more capital infrastructure dollars in the future. It also leaves open the possibility that the freeway-to-freeway interchange might be built by delaying a decision on this section of highway until fairly late in the program.

The program proposed in Table 23 would begin with the construction of the frontage roads between 103rd and 131st streets. This will be needed in order to provide for maintenance of traffic during the construction of subsequent phases. Project "5" (i.e., the segment largely between 136th and 161st streets) would be built next. Construction would then systematically move south in

TABLE 23
RECOMMENDED PHASING OF PROJECT SEGMENTS
US 31 Hamilton County Major Investment Study

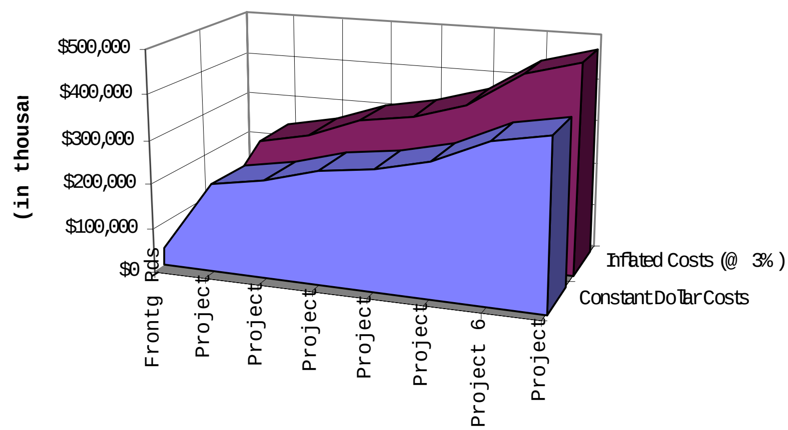
Phase	Project Segment
Phase 1	Frontage Roads (103rd / 106th streets to 131st Street)
Phase 2	Project "5" (146th / 151st Street Interchange and segment between 161st & 136th streets)
Phase 3	Project "4" (136th Street segment)
Phase 4	Project "3" (North of 131st to north of 116th streets)
Phase 5	Project "2" (116th Street segment)
Phase 6	Project "0" (Segment from south of 116th Street to I-465 including Fr-to-Fr Interchange) or Project "1" (Same segment ending at 103rd Street)
Phase 7	Projects "6" and "7" (Segments from north if 161st Street to @ 186th Street)
Phase 8	Project "8" (Segment from 186th Street to northern terminus @ 196th Street)

stages without any leapfrogging. Concentrating early efforts between 116th and 161st streets makes sense from the standpoint that these are the fastest growing segments of the corridor. After the completion of Project "2" (i.e., the 116th Street area), the decision as to whether or not Project "0" or Project "1" should be built could be made at that time on the basis of available funding and competing needs. Delaying construction on this southern segment can also be justified in that the area south of 106th Street already has more capacity than segments farther north. It also mitigates the chances that Project "1" would ever need to be ripped out and reconstructed along the lines of Project "0". The final two phases would then move to the north end of the corridor where traffic volumes are comparatively low and anticipated growth is farthest in the future.

ESTIMATE OF INFLATED COSTS

Figures 43 and 44 show the recommended phasing program and cumulative costs for the corridor improvement assuming Project "1" and Project "0",

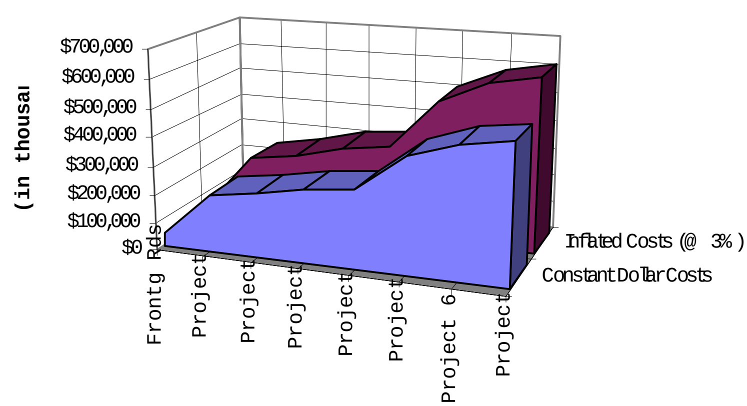
FIGURE 43 RECOMMENDED PHASING & COST ACCUMULATION WITHOUT FREEWAY-TO-FREEWAY INTERCHANGE



RECOMMENDED PROJECT PHASING & COSTS: CONSTANT 1996 AND INFLATED DOLLARS (assuming project beginning @ 2001)

	2001	2002	2003	2004	2005	2006	2007	2008	Cumulative Totals
Project	Frontg Rds	Project 5	Project 4	Project 3	Project 2	Project 1	Project 6 & 7	Project 8	
Constant Dollar Costs	$41,606	$159,590	$20,913	$34,402	$15,879	$26,268	$55,796	$23,879	$378,333
Inflated Costs (@ 3%)	$48,233	$190,559	$25,720	$43,579	$20,718	$35,302	$77,235	$34,046	$475,392

FIGURE 44 RECOMMENDED PHASING & ACCUMULATED COSTS WITH FREEWAY-TO-FREEWAY INTERCHANGE



RECOMMENDED PROJECT PHASING & COSTS: CONSTANT 1996 AND INFLATED DOLLARS (assuming project beginning @ 2001)

	2001	2002	2003	2004	2005	2006	2007	2008	Cumulative Totals
Project	Frontg Rds	Project 5	Project 4	Project 3	Project 2	Project 0	Project 6 & 7	Project 8	
Constant Dollar Costs	$41,606	$159,590	$20,913	$34,402	$15,879	$131,082	$55,796	$23,879	$483,147
Inflated Costs (@ 3%)	$48,233	$190,559	$25,720	$43,579	$20,718	$176,163	$77,235	$34,046	$616,254

respectively. The figures depict the costs in both constant 1996 dollars and estimated inflated dollars.

Inflation estimates are based on an assumed inflation rate of 3% with Phase 1 beginning in 2001. Given these assumptions, the 1996 price tag of $383 million cost for all of the corridor improvements would inflate to about $475
million assuming the freeway-to-freeway interchange in *not* built. If it *is* built, the $483 million cost would escalate to approximately $616 million.